

KAMMER PLANT
DEMONSTRATION DOCUMENT
FOR PL 92-500 § 316(b)

VOLUME II

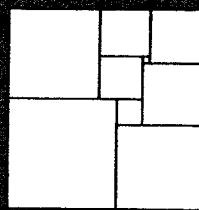
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KAMMER PLANT
FISH IMPINGEMENT AND ENTRAINMENT STUDIES

PREPARED FOR

AMERICAN ELECTRIC POWER SERVICE CORPORATION



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FISH IMPINGEMENT AND ENTRAINMENT STUDIES

PREPARED FOR
AMERICAN ELECTRIC POWER SERVICE CORPORATION

PREPARED BY
NORTHERN ENVIRONMENTAL SERVICES DIVISION-PITTSBURGH
WAYNE A. POTTER
EDWARD D. MARUHNICH
ROBERT L. SHEMA
CYNTHIA J. COOK

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CLIENT NO. 6774

APPROVED BY

Edward D. Maruhnich
EDWARD D. MARUHNICH
PROJECT MANAGER

Brownie R. Johnson
BROWNIE R. JOHNSON
MANAGER, NORTHERN
ENVIRONMENTAL SERVICES
DIVISION

Barton C. Marcy, Jr.
BARTON C. MARCY, JR.
MANAGER, AQUATIC ECOSYSTEMS
DEPARTMENT

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INTRODUCTION

American Electric Power Service Corporation (AEP) contracted NUS Corporation in April 1978 to conduct a fish impingement and ichthyoplankton entrainment study at the Kammer Plant of Ohio Power Company. The Kammer Plant is located on the Ohio River 1 mi downstream of Captina, in Marshall County, West Virginia at river mile 111.1. The plant consists of three coal fired units with a combined nominal generating capacity of 712.5 MW.

The purpose of the impingement and entrainment studies was to provide sufficient data to allow estimation of the total annual fish impingement and fish eggs and larvae entrainment at the plant.

METHODS

IMPINGEMENT

Weekly impingement collections (28-hr surveys) were initiated on May 8, 1978 and continued through October 24, 1978.

Biweekly collections were started on November 6 and continued to March 30, 1978 after which weekly collections were again started and continued through May 1, 1979. Plant personnel were contacted to rotate and clean the traveling screens prior to and at 4-hr intervals during each 28-hr survey. After the initial cleaning, a fish collection basket was placed at the lower end of the screen wash trash trough where debris normally drops into the discharge tunnel through a concrete well located outside of the screen house. Mesh size of the collection basket was 0.375 inch square.

After each 4-hr collection, all fishes were sorted from the debris and immediately categorized into three groups: (1) live; (2) dead; and (3) obviously dead prior to impingement. Obviously dead fish were differentiated on the basis of advanced stages of decomposition and were not included in data base used to estimate annual impingement. Numbers of fishes in categories one and two are reported in Table 1 of Appendix A; fish in category three are reported in Table 2 of Appendix A. Each specimen was identified to the lowest

feasible taxon, usually species. Total length (mm) and weight (g) were measured on all specimens except when more than 30 specimens per species per 4-hr period were collected. Subsampling was preformed when more than 30 specimens per species were collected per 4-hr period. Fish excluded from the subsamples were weighed as a group to provide a bulk weight. A voucher collection was developed and all species identifications were confirmed in the laboratory.

An estimate of the number of fish impinged per year at the Kammer Plant was made by multiplying the average number of fish impinged during the first 24 hr of each 28-hr survey times 365 days per year. Ninety five percent confidence limits for the estimated number of fish impinged per year based on the average per 24 hr were calculated using the t-distribution of Snedecor and Cochran (1967).

ENTRAINMENT

Ichthyoplankton was sampled weekly from 13 March through 31 August, twice monthly in September and October and monthly November through February, 1978-1979. Samples were taken from taps off one circulating water pump of each operating unit. Each sample consisted of a 24-hr continuous sample for each unit. The volume of water sampled generally exceeded 100 m³ to minimize the problem of non-random sampling of

large volumes of cooling water, but was limited by the capacities of the sump pumps in the intake structure.

Intake water was "tapped" from a circulating water pump through existing valves, through a one inch (I.D.) hose and into a 0.5 m diameter 0.505 mm mesh net suspended in a 55 gal drum (Figure 1). Originally, a second net was placed around the 0.5 m net to prevent sample loss in the event of clogging and over-flowing. The use of the second net was found to be unnecessary and was discontinued. Each net was tended at approximately 6-hr intervals and a sample removed and preserved. Sample volume was determined at 3-hr intervals through use of a General Oceanics Model 2030 flow meter placed in-line on the discharge from the 55 gal drum and verified with time-volume measurements from the discharge pipe (Figure 1).

Samples were preserved in 5% buffered formalin and stained with rose bengal dye. Each sample was sorted in the laboratory and specimens identified to the lowest feasible taxa. Approximately 5% of the samples were resorted yielding a sorting accuracy of 95%. Samples from September through February were taken, but at the request of AEP were not analyzed.

Estimates of ichthyoplankton abundance were calculated using the following formulae adapted from Potter et al. (In Press):

Total 24-hr estimates (E_{24}) were made using the following formula:

$$E_{24} = \sum_{u=1}^3 \sum_{t=1}^3 (4363.2) (P_u) (T_t)$$

where 4363.2 = number of 100 m^3 volume units through each pump per 24 hr

P_u = number of pumps operating in each unit

T_t = The number of specimens of each taxon per 100 m^3

u = The different power station units

t = The different taxa collected

Estimates of numbers of ichthyoplankton entrained per month

(E_{mo}) were calculated using the following formula:

$$E_{mo} = \sum_{e=1}^m \sum_{t=1}^n d(T_{24})$$

where

d = Number of days represented by a 24-hr estimate

T_{24} = The estimated number of each taxon entrained per 24 hr

e = The number of 24-hr estimates per month

t = The different taxa collected

The total estimated number of ichthyoplankton entrained by the Kammer Plant (E_{tot}) was the sum of the month estimates:

$$E_{tot} = \sum_{i=1}^n E_{mo}$$

where

E_{mo} = The estimated number of ichthyoplankton entrained per month

i = The months estimates were made

To make the above estimates of entrainment, it was assumed that the densities and composition of ichthyoplankton entrained per 24 hr were the same for all days represented by single estimates. In addition, it was assumed that no ichthyoplankton were entrained from September through February.

PLANT OPERATING AND FIELD DATA

Intake and discharge temperatures and barometric pressure (in. of Hg) were obtained at 4-hr intervals from plant instruments. Temperature readings were instantaneous readings, therefore, these readings cannot be related to those contained in NPDES monitoring reports. Wind direction, speed, percent cloud cover, air temperature and river elevation were obtained at 4-hr intervals by the field crew. In addition, the Plant Manager was contacted to obtain

records of unit outages and the chlorination schedule during the course of the impingement and entrainment survey.

The number of operating circulating water pumps was determined for each entrainment and impingement sampling period to allow estimation of daily circulating water volume.

Current speed measurements were taken in front of the traveling screens during April, May, June, August and October 1978 and July 1979. On July 11, 1979 an extensive survey was conducted to collect current speed and direction data in the river in front of the Kammer Plant intake structure. These date are presented in Appendix D.

TABLE I (Continued)

	Dec-1978			Jan-1979			Feb-1979			Mar-1979			Apr-1979			Total		
	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)	No.	Wt. (g.)
Gizzard shad	305	2,961	7	280	3	78	1	62	-	-	9,98	8,045	-	-	1	645	-	-
Northern pike	-	-	1	282	-	-	-	-	-	-	-	-	-	-	2	514	-	-
Goldfish	-	-	-	-	1	-	-	-	-	-	-	-	-	-	8	2,576	-	-
Carp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5	-	-
Silver chub	-	-	-	-	-	1	5	-	-	-	-	-	-	-	1	37	-	-
Golden shiner	4	14	1	2	1	4	2	10	7	22	219	451	-	-	-	-	-	-
Emerald shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6	-	-
Mimic shiner	-	-	-	-	-	-	-	-	-	2	11	6	38	-	-	-	-	-
Bluntnose minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	15	-	-
Minnow (Cyprinidae)	1	621	-	-	-	-	-	-	-	-	-	-	-	-	1	621	-	-
Quillback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	417	-	-
White sucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	36	1	36
Northern hog sucker	-	-	-	-	-	-	-	-	-	1	36	10	1,525	-	-	-	-	-
Silvery redhorse	4	1,427	-	-	2	543	-	-	1	355	4	1,407	10	2,709	-	-	-	-
Golden redhorse	-	-	-	-	-	-	-	-	1	114	-	-	-	3	374	-	-	
Redhorse (<i>Moxostoma</i>)	2	54	10	766	-	-	-	-	1	14	-	-	-	-	1	14	-	-
Sucker (Catostomidae)	-	-	-	-	1	57	-	-	-	-	-	-	-	-	1	57	-	-
White catfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	12	-	-
Yellow bullhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	134	-	-
Brown bullhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	428	-	-
Channel catfish	-	-	-	-	1	19	-	-	-	-	-	-	-	-	3	6	-	-
Catfish (<i>Ictalurus</i>)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	39	-	-
Flathead catfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	18	-	-
Walleye perch	3	38	-	-	-	-	-	-	-	-	-	-	-	-	20	249	-	-
White bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	68	-	-
Temperate bass (<i>Morone</i>)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-
Rock bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	29	-	-
Green sunfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	156	-	-
Pumpkinseed	9	68	-	-	-	-	-	-	-	-	-	-	-	-	2	310	-	-
Bluegill	-	-	-	-	-	-	-	-	-	2	102	33	438	-	18	-	-	-
Longear sunfish	2	30	-	-	-	-	-	-	-	-	-	-	-	-	2	56	-	-
Sunfish (<i>Lepomis</i>)	-	-	1	240	-	-	-	-	-	-	-	-	-	-	4	69	-	-
Spotted bass	-	-	1	3	-	1	11	-	-	-	-	-	-	-	1	130	3	215
Largemouth bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	183	-	-
Sunfish (<i>Micropterus</i>)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	37	513	-
White crappie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	6	-	-
Black crappie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-
Sunfish (Centrarchidae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	16	-	-
Yellow perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	183	-	-
Logperch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	6	-	-
Darter (Percidae)	-	-	-	-	1	3	-	-	-	-	-	-	-	-	1	3	-	-
Sauger	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1,164	8	1,421
Freshwater drum	9	54	-	-	-	-	-	-	-	-	-	-	-	-	29	1,323	-	-
Total	341	5,510	25	1,963	5	87	12	699	66	3,893	1,535	30,799	-	-	-	-	-	-

SEASONAL OCCURRENCE

The number and biomass of fish collected per 28-hr impingement survey varied considerably (Figures 2 and 3). The obvious peaks of abundance and biomass during October through December were a result of an increase in impingement of numbers of gizzard shad (Figure 2). The May and June biomass peaks were a result of impingement of a few large channel catfish (Table 1).

The gizzard shad was collected during July 1978 through March 1979 with highest totals in November and December (Table 1). The emerald shiner was collected in relatively low numbers every month with most collected in May 1978. The channel catfish was collected in all months except June, July 1978, and February 1979. Numbers of channel catfish impinged per month were low, with 28 collected in August being the highest total (Table 1). Other species were collected sporadically with no obvious pattern of occurrence.

DIEL OCCURRENCE

The number of fish collected per 4-hr period showed some variation within each 28-hr study. The data from complete 28-hr surveys with comparable series of 4-hr time blocks (33 surveys) were analyzed using the large sample approximation,

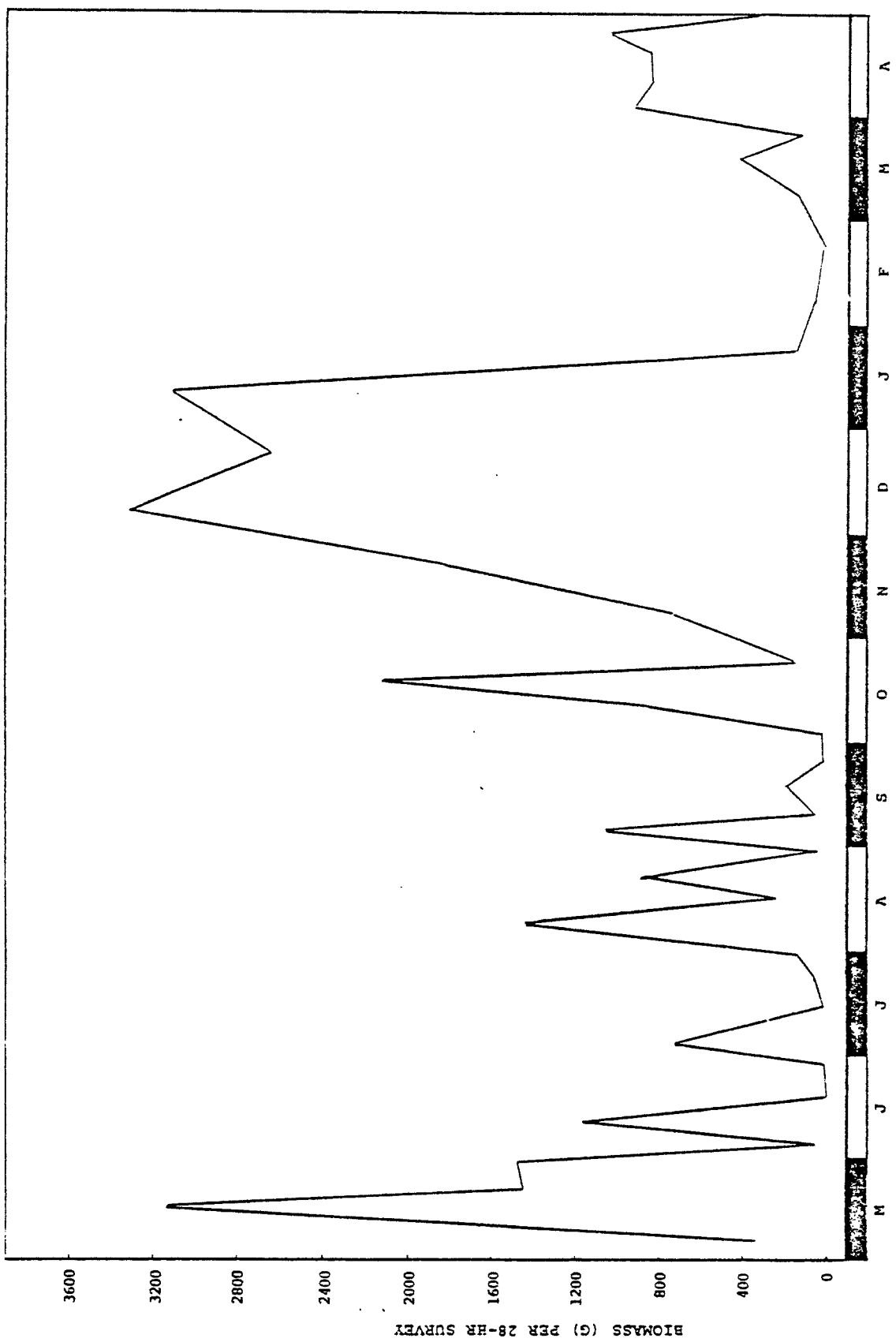


FIGURE 3

BIOMASS OF FISH IMPINGED PER 28-HR PERIOD AT THE KAMMER PLANT
MAY 1978 THROUGH APRIL 1979

adjusting for ties, of Friedman's two-way analysis of variance by ranks (Hollander and Wolfe 1973) to test if there was any significant difference in the impingement rate per 4-hr sampling period. The hypothesis that there was no difference between sampling periods was rejected at $P=0.06$ indicating that there was weak evidence to reject the hypothesis.

ANNUAL LOSS ESTIMATES

An annual estimate of fish lost due to impingement at the Kammer Plant was determined, based on the numbers of fish impinged during the first 24 hr of each survey. Data for surveys which were not 24 hr in duration were adjusted to represent 24-hr periods which resulted in an average number impinged per 24 hr of 34.3 fish and standard deviation of 76.119. The average per 24-hr survey was multiplied by 365 days per year to yield an annual estimate of impingement of 12,520 fish. The 95% confidence limits of number of fish impinged were 3,750 (lower limit) and 21,290 (upper limit).

RELATION OF FISH IMPINGEMENT TO PREVAILING CONDITIONS

Plant operating and field data are reported in Appendices B and D. The most obvious relationship seemed to be the increased impingement of gizzard shad with low ambient river water temperatures.

ENTRAINMENT

CATCH COMPOSITION

A total of 24 entrainment studies was performed from March through August 1978. No ichthyoplankton was collected before May 8-9. After May 9, larvae of at least six families were collected. In text and tables, identification indicates fish larvae; eggs were lumped as one taxon. Detail data are reported in Appendix B and are summarized in this section.

The number of ichthyoplankton per 100 m³ ranged from 0 to 598.8 but was usually less than 30 (Table 3). Cyprinids were apparently most abundant but unidentifiable specimens were common also. Greatest densities occurred in June and July.

ESTIMATES OF ICHTHYOPLANKTON ENTRAINED

Estimates of the number of ichthyoplankton entrained per 24 hr by the Kammer Plant ranged from 0 to 10.4 million (Figure 4). Peak abundances were in June and July. An estimated 182 million larval fish and eggs were entrained by the plant (Table 4) assuming there were no ichthyoplankton present during September through February. Minnow larvae and unidentifiable larvae accounted for 61.1 and 33.8% of the entrained ichthyoplankton, respectively. Carp (2.6% of total) and herring (1.2%) were also somewhat common.

TABLE 3
NUMBER OF TETRHYPOPLANKTON PER 100 m³ FOR EACH TAXON COLLECTED AT OPERATING
UNITS OF THE FARMER PLANT, 1978

	13-14 Mar			20-21 Mar			27-28 Mar			3-4 Apr			10-11 Apr			17-18 Apr			24-25 Apr			
	1-N	2-N	1-N	2-N	1-N	2-N	1-N	2-N	1-N	2-N	1-N	2-N	1-N	2-N	1-N	2-N	1-N	2-N	1-N	2-N	1-N	2-N
Herring (Clupeidae)																						
Carp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	-	-	-	-	-	-	
Minnow (Cyprinidae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Specimens	-	-	-	-	-	0.6	
Sucker (Catostomidae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Collected	-	-	-	-	-	-	
Catfish (Ictaluridae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
White bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Yellow perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Walleye/Sauvage (<u>Stizostedion</u>)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Percid (Percidae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Unidentifiable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Eqns	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	
Herring (Clupeidae)																						
Carp	No	-	No	-	No	-	No	-	No	-	No	-	No	-	No	-	No	-	No	-	-	
Minnow (Cyprinidae)	Specimens	-	Specimens	-	Specimens	-	Specimens	-	Specimens	-	Specimens	-	Specimens	-	Specimens	-	Specimens	-	Specimens	-	-	
Sucker (Catostomidae)	Collected	-	Collected	-	Collected	-	Collected	-	Collected	-	Collected	-	Collected	-	Collected	-	Collected	-	Collected	-	-	
Catfish (Ictaluridae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
White bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Yellow perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Walleye/Sauvage (<u>Stizostedion</u>)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Percid (Percidae)	0.7	0.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	
Unidentifiable	-	-	0.7	0.7	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	
Eqns	0.7	1.4	29.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	
Total	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	

TABLE 3 (Continued)

	5-6 Jun			12-13 Jun			19-20 Jun			26-27 Jun			3-4 Jul			17-18 Jul			24-25 Jul		
	1-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N
Herring (Clupeidae)	-	-	-	0.9	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carp	23.3	6.8	20.4	7.0	9.8	0.9	-	-	-	2.1	5.5	0.6	-	-	-	-	-	-	-	-	-
Minnow (Cyprinidae)	5.8	6.1	13.6	28.9	51.6	34.0	118.8	13.3	18.2	491.9	-	-	-	-	-	-	-	-	-	23.9	-
Sucker (Catostomidae)	-	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Catfish (Ictaluridae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
White bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walleye/Sauger (<u>Stizostedion</u>)	-	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Percid (Percidae)	0.6	-	-	2.6	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-
Unidentifiable	11.0	11.4	6.8	38.6	38.2	80.6	38.8	35.0	103.2	103.0	85.8	20.0	-	-	-	-	-	-	-	-	-
Baits	-	-	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	40.7	27.4	43.1	78.0	100.4	115.5	159.2	50.9	129.2	598.8	85.8	20.0	-	-	-	-	-	-	-	123.5	-
	31 Jul-1 Aug			7-8 Aug			14-15 Aug			21-22 Aug			28-29 Aug			1-N			1-N		
	1-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N	2-N	3-N
Herring (Clupeidae)	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carp	-	-	-	-	-	-	1.6	0.7	-	-	-	-	-	-	-	-	-	-	-	0.9	25.6
Minnow (Cyprinidae)	66.3	41.3	3.8	9.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	2.9
Sucker (Catostomidae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Catfish (Ictaluridae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
White bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walleye/Sauger (<u>Stizostedion</u>)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Percid (Percidae)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentifiable	31.7	34.9	16.2	15.2	-	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-
Encls	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	98.0	76.2	20.0	25.7	-	-	4.8	1.4	-	-	-	-	-	-	-	-	-	-	7.1	29.5	-

TABLE 4
ESTIMATES¹ OF ICHTHYOPLANKTON ENTRAPMENT PER MONTH
AT THE KAMMER PLANT, 1978

Month	March	April	May	June	July	August	Total	Percent
Herring (Clupeidae)	-	-	42,800	77,700	209,000	1,792,200	2,121,700	1.16
Carp	-	-	20,900	4,455,900	166,700	127,100	4,770,600	2.62
Minnnow (Cyprinidae)	-	-	-	16,572,300	39,416,600	5,260,400	111,249,300	61.06
Sucker (Catostomidae)	-	-	42,800	140,600	-	-	183,400	0.10
Catfish (Ictaluridae)	-	-	-	82,400	-	-	82,400	0.04
White bass	-	-	-	82,400	-	-	82,400	0.04
Yellow perch	-	-	-	54,100	427,000	-	481,100	0.26
Walleye/Bauger (<i>Stizostedion</i>)	-	429,700	-	49,500	-	-	478,200	0.26
Percid (Percidae)	-	-	142,600	4,400	-	-	-	-
Unidentifiable	-	-	142,800	19,813,500	36,579,400	5,086,500	147,000	0.08
Eqns	-	843,000	-	140,500	-	-	61,622,200	33.82
Total	0	1,522,000	41,610,500	126,303,100	12,266,200	182,201,800		0.54

¹ Numbers rounded to nearest hundred

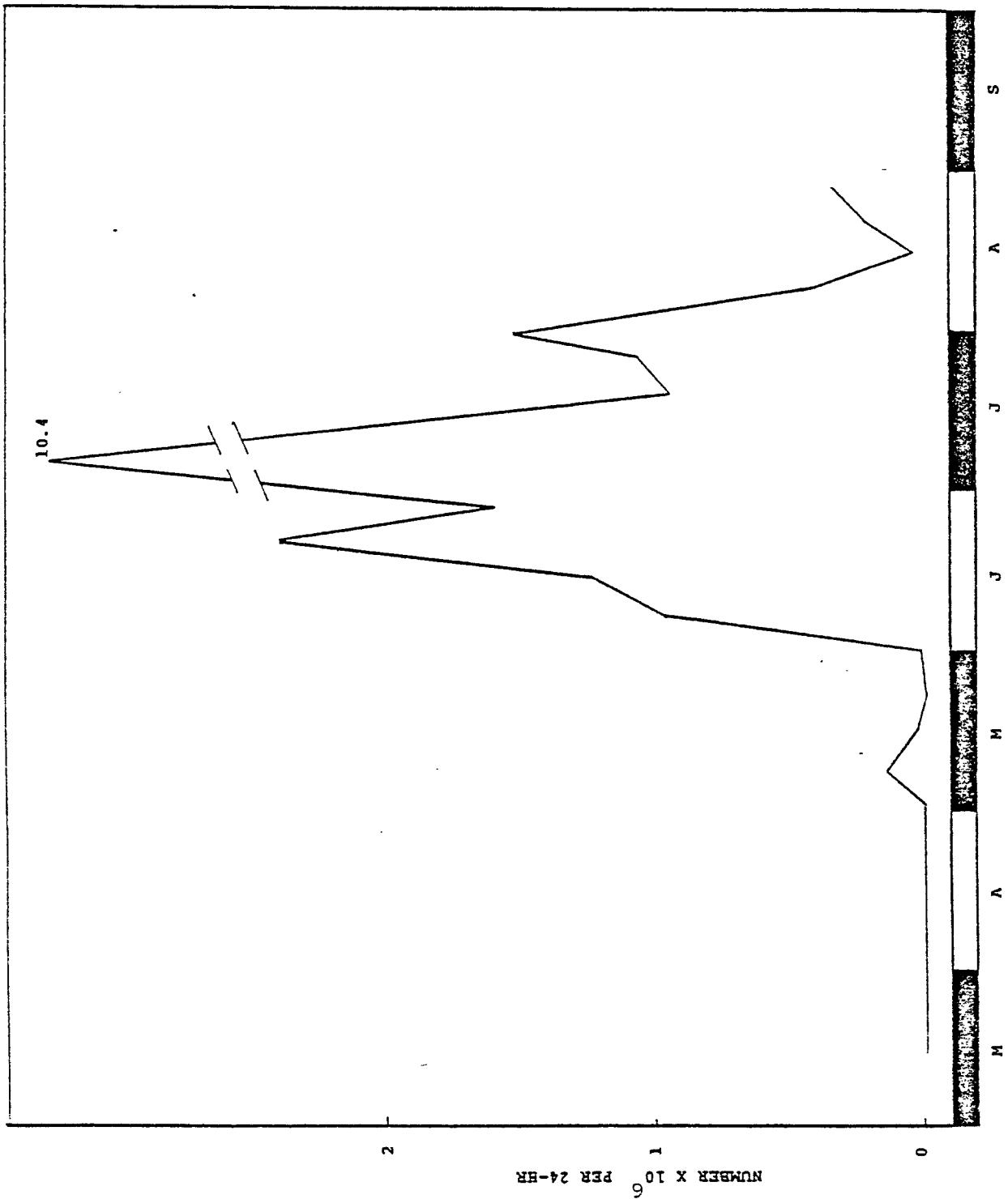


FIGURE 4

ESTIMATES OF ICHTHYOPLANKTON ENTRAINED PER 24-HR PERIOD AT THE MOUTH OF THE COLUMBIA RIVER

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APPENDIX A

KAMMER PLANT
IMPIGNEMENT DATA

<u>Table</u>	<u>Title</u>
1	NUMBER, LENGTH, WEIGHT AND STATUS OF IMPINGED FISH BY SURVEY DATE AT THE KAMMER PLANT DURING 1978-1979
2	NUMBERS OF FISH IMPIGNED AT THE KAMMER PLANT CONSIDERED DEAD PRIOR TO BECOMING IMPIGNED

TABLE 1

NUMBER, LENGTH, WEIGHT AND STATUS OF IMPINGED FISH BY SURVEY DATE
AT THE KAMMER PLANT DURING 1978-1979^a

Date & Time 1978	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
May 8 0800-1505	Emerald Shiner Bluegill	2 1	65-72 127	4 33	2 1	
1505-1930	White crappie Longear sunfish	1 1	73 88	5 19	1 1	
1930-2315	Emerald shiner Brown bullhead	3 1	58-70 130	2 26	3 1	
May 9 2315-0330	Bluegill Black crappie White crappie	2 1 1	136-149 181 72	94 74 4	2 1 1	
0330-0800	Emerald shiner	3	66-68	4 ^b	3	
0800-1200	Emerald shiner Carp	3 1	64-68 106	4 ^b 16	3 1	
May 15 0700-1430	Emerald shiner Channel catfish	10 1	45-79 320	13 233	10 1	
1430-1830	Emerald shiner Channel catfish	1 1	57 160	1 33	1 1	
1830-2330	Emerald shiner	5	60-73	5	5	

^a Does not include fish presumed to be dead prior to coming within the influence of the intake.

^b Weight estimated from average weight per specimen for this species collected during 24-hr study.

^c Unable to sample because of below freezing conditions.

TABLE 1 (continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
May 16 2330-0230	Emerald shiner	17	50-85	22		17
	Channel catfish	1	211	76	1	1
	Brown bullhead	1	220	92	1	1
	Sauger	1	210	68	1	1
0230-0645	Emerald shiner	15	60-76	21		15
	Channel catfish	3	170-460	1,171	2	1
	Northern pike	1	430	645	1	1
0645-1037	Emerald shiner	5	62-80	7	5	1
	Carp	1	300	302	1	1
May 22 0730-1150	Emerald shiner	15	45-72	21		15
	Silver redhorse	1	393	780	1	1
	Bluegill	1	67	6	1	1
1150-1550	Emerald shiner	10	55-77	20		10
	Logperch	1	83	6	1	1
	Green sunfish	1	110	19	1	1
1550-2000	Emerald shiner	10	62-73	19		10
	Channel catfish	1	210	72	1	1
2000-2400	Emerald shiner	5	63-107	11	5	5
May 23 2400-0400	Emerald shiner	2	62-63	2		2
	Carp	1	96	12	1	1

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
May 23 0400-0800	Emerald shiner	8	40-82	16		8
	Channel catfish	2	310-315	452	2	
	Sunfish (Centrarchidae)	1	40	4		1
	Sunfish (<u>Lepomis</u>)	1	90	14	1	
0800-1145	Emerald shiner	8	51-70	12		8
May 29 0730-1130	Emerald shiner	1	63	2		1
1130-1520	Emerald shiner	1	65	3		1
1520-2020	Emerald shiner	3	65-73	12		3
	Silver redhorse	1	298	356		1
May 30 2020-0020	No fish collected					5
0020-0420	Emerald shiner	5	51-80	11		
	Silver redhorse	1	270	206	1	
0420-0820	Emerald shiner	4	62-70	6		4
	Silver redhorse	1	290	274		1
	Carp	1	358	592		1
0820-1220	Emerald shiner	2	65-71	6		2
	Sunfish (Centrarchidae)	1	85	10		1
	Sunfish (<u>Lepomis</u>)	1	95	16		1

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
June 5 0730-1120	Emerald shiner	1	65	1		1
1120-1520	Emerald shiner	1	70	2		1
1520-1920	No fish collected					
1920-2320	Emerald shiner	3	67-76	9		3
	Bluntnose minnow	1	82	7		1
June 6 2320-0320	Emerald shiner	11	56-79	28		11
0320-0720	Emerald shiner	14	62-79	36		14
0720-1120	Emerald shiner	3	67-73	5		3
June 12 0730-1200	No fish collected					
1200-1600	Emerald shiner	1	86	2		1
	Freshwater drum	1	424	1,180		1
1600-2000	Green sunfish	1	83	10		
2000-2350	No fish collected					
June 13 2350-0350	Emerald shiner	1	80	4		1
0350-0750	Emerald shiner	1	66	2		1
0750-1150	No fish collected					

TABLE 1 (Continued)

<u>Date & Time</u>	<u>Taxon</u>	<u>Number</u>	<u>Total Length Range (mm)</u>	<u>Weight (g)</u>	<u>Alive</u>	<u>Dead</u>
June 19 0700-1120	No fish collected					
1120-1520	No fish collected					
1520-1920	No fish collected					
1920-2320	No fish collected					
June 20 2320-0340	No fish collected					
0340-0720	No fish collected					
0720-1120	No fish collected					
June 26 0700-1120	No fish collected					
1120-1520	Emerald shiner	1		77	2	1
1520-1920	No fish collected					
1920-2320	No fish collected					
June 27 2320-0320	No fish collected					
0320-0725	No fish collected					
0725-1120	No fish collected					

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
<u>July 3</u> 0630-1050	No fish collected					
1050-1450	Largemouth bass	1	184	70		1
1450-1850	Emerald shiner	2	55-65	7		2
	Pumpkinseed	1	75	10		1
	Bluegill	1	51	1		1
	Temperate bass (<u>Morone</u>)	1	187	68	1	
1850-2250	No fish collected					
<u>July 4</u> 2250-0250	Emerald shiner	1	61	2		1
	Redhorse (<u>Moxostoma</u>)	1	247	135		1
0250-0650	White sucker	1	200	115		1
	Spotted bass	1	191	100		1
0650-1050	Emerald shiner	1	72	3		1
	Carp	1	272	210		1
<u>July 10</u> 0940-0955	No fish collected					
0955-1350	No fish collected					
1350-1750	No fish collected					
1750-2200	Trout-perch	1	70	1		1
	Goldfish	1	224	232		1
	Bluegill	1	68	6		1

TABLE 1 (Continued)

<u>Date & Time</u>	<u>Taxon</u>	<u>Number</u>	<u>Total Length Range (mm)</u>	<u>Weight (g)</u>	<u>Alive</u>	<u>Dead</u>
July 11 2200-0150	No fish collected					
0150-0550	No fish collected					
0550-0955	Longear sunfish	1	115	37	1	
July 17 0330-0900	No fish collected					
0900-1250	No fish collected					
1250-1700	No fish collected					
1700-2030	No fish collected					
July 18 2030-0050	Emerald shiner	2	70-83	4	2	
0050-0450	Emerald shiner	1	63	2	1	
0450-0850	No fish collected					
July 24 0700-1120	No fish collected					
1120-1520	No fish collected					
1520-1920	Sauger	1	242	78	1	
1920-2320	No fish collected					

2

TABLE 1 (Continued)

<u>Date & Time</u>	<u>Taxon</u>	<u>Number</u>	<u>Total Length Range (mm)</u>	<u>Weight (g)</u>	<u>Alive</u>	<u>Dead</u>
<u>July 25</u>						
2320-0330	No fish collected				1	1
0330-0720	No fish collected					
0720-1120	No fish collected					
<u>July 31</u>						
0300-0820	No fish collected	1	45	1		
0820-1220	Catfish (<u>Ictalurus</u>) Golden redhorse	1	269	180		
1220-1620	No fish collected					
1620-2020	No fish collected					
<u>August 1</u>						
2020-0020	No fish collected	1	85	5		
0020-0420	Gizzard shad Catfish (<u>Ictalurus</u>)	1	55	1	1	
0420-0820	Gizzard shad Catfish (<u>Ictalurus</u>)	2	95-104	21	2	
		1	64	4	1	

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
1978						
August 7 0700-1120	Yellow bullhead Channel catfish	2 1	57-70 56	8 2		
	No fish collected				1	1
1120-1520	Spotted bass	1	78	4		
1520-1920	Emerald shiner	1	55	1	1	1
1920-2320	Golden shiner Channel catfish	1 1	113 60	37 2	1	1
August 8 2320-0320	Gizzard shad Emerald shiner Channel catfish	3 2 1	80-105 53-79 64	28 6 2	3 2 1	
	Gizzard shad Channel catfish Bluntnose minnow Mimic shiner	23 2 2 1	80-130 59-66 66-76 58-63	287 8 10 6	23 2 2 1	
	Carp	1	273	215		
	Channel catfish Brown bullhead	1	468 76	812 6	1	1
0720-1120						

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
August 14 0730-1150	No fish collected					
1150-1550	Gizzard shad	2	51	3		2
1550-1945	Emerald shiner	1	52	1		1
1945-2350	Gizzard shad	5	99-110	55		5
	Channel catfish	2	59-60	6		2
	Emerald shiner	1	80	3		1
	Bluegill	1	80	9		1
	Spotted bass	1	63	2		1
August 15 2350-0335	Gizzard shad	5	98-114	64		5
	Channel catfish	1	78	4		1
0335-0750	Gizzard shad	2	113-124	32		2
	Brown bullhead	1	78	6		1
	White crappie	1	60	3		1
0750-1150	Channel catfish	1	65	3		1
	Bluegill	1	127	40		1
August 21 0630-1050	Channel catfish	1	70	3		1
1050-1453	Channel catfish	2	59-81	9		2
1453-1850	Channel catfish	1	76	4		1
1850-2250	Channel catfish	6	50-345	307		6
	Gizzard shad	4	95-106	40		4
	Golden redhorse	1	232	134		1

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TABLE 1 (Continued)

<u>Date & Time</u>	<u>Taxon</u>	<u>Number</u>	<u>Total Length Range (mm)</u>	<u>Weight (g)</u>	<u>Alive</u>	<u>Dead</u>
August 22 2250-0250	Gizzard shad	3	90-102	30		3
	Channel catfish	2	62-68	6		2
	White sucker	1	312	302		1
0250-0650	Channel catfish	2	62-68	7		2
	Gizzard shad	1	118	18		1
	Gizzard shad	1	102	10		1
0650-1050	Emerald shiner	1	80	2		1
August 28 0630-1050	No fish collected					
	No fish collected					
	Channel catfish	3	54-72	6		3
1050-1450 1450-1850 1850-2300	No fish collected					
	No fish collected					
	No fish collected					
August 29 2300-0300 0300-0650 0650-1050	No fish collected					
	Channel catfish	1	90	6		1
	Flathead catfish	1	73	4		1
	Flathead catfish	1	90	4		1
	Yellow bullhead	1	75	4		1

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TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
September 4 1978 0330-0755	Freshwater drum Bluegill	1 1	78 53	4 2	1	
0755-1150	Gizzard shad Redhorse (<u>Moxostoma</u>) Sunfish (Centrarchidae)	2 1 1	138-142 237 49	52 125 2	2 1 1	
1150-1550	No fish collected	1	68	4	1	
1550-1950	Brown bullhead	18	121-156	432	18	
1950-2350	Gizzard shad Channel catfish Pumpkinseed	1 1 1	65 52	2 1	1 1	
September 5 2350-0350	Gizzard shad Gizzard shad Channel catfish	7 11 1	117-142 122-157 56	157 294 3	7 11 1	
September 11 0630-1100 1100-1500 1500-1900 1900-2300	No fish collected Channel catfish No fish collected Channel catfish	1 1 2	126	16	1 3 2	

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TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
September 12 2300-0300	Channel catfish	2	65-93	12	2	
0300-0700	Channel catfish	1	63	4	1	
0700-1100	No fish collected					
September 18 0630-1050	No fish collected					
1050-1450	No fish collected					
1450-1850	No fish collected					
1850-2250	Emerald shiner	1	71	4	1	
September 19 2250-0250	No fish collected					
0250-0650	Gizzard shad	1	182	60	1	
	Channel catfish	1	86	3	1	
	Yellow perch	1	242	118	1	
0650-1050	White crappie	1	86	6	1	
September 25 0630-1050	No fish collected					
1050-1450	No fish collected					
1450-1850	No fish collected					
1850-2250	No fish collected					

TABLE 1 (Continued)

<u>Date & Time</u>	<u>Taxon</u>	<u>Number</u>	<u>Total Length Range (mm)</u>	<u>Weight (g)</u>	<u>Alive</u>	<u>Dead</u>
<u>September 26</u>						
2250-0250	No fish collected					
0250-0650	Emerald shiner	2	51-62	5		2
0650-1050	No fish collected					

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
1978 0630-1050	No fish collected					
1050-1450	No fish collected					
1450-1850	Channel catfish	1	395	520	1	1
	Freshwater drum	1	58	3		
1850-2250	Freshwater drum	2	65-68	6	2	
October 2 2250-0240	Freshwater drum	1	61	2	1	
0240-0650	Gizzard shad	1	145	28	1	
0650-1050	No Sample					
October 9 0630-1050	Carp	1	329	433	1	
	Golden redhorse	1	216	90		1
	Channel catfish	1	182	35		1
1050-1450	No fish collected					
1450-1850	Gizzard shad	2	123-187	80	2	
1850-2250	Gizzard shad	1	58	2	1	
	Channel catfish	1	182	38	1	
	Bluegill	1	63	5		1

W

TABLE 1 (Continued)

<u>Date & Time</u>	<u>Taxon</u>	<u>Number</u>	<u>Total Length Range (mm)</u>	<u>Weight (g)</u>	<u>Alive</u>	<u>Dead</u>
October 10 2250-0250	Channel catfish	1	224	66	1	1
0250-0650	Gizzard shad	1	146	30		
	Emerald shiner	1	69	3		
	Yellow perch	1	197	65	1	
0650-1050	No fish collected					
October 16 0630-1050	Gizzard shad	19	55-179	218	19	1
	Freshwater drum	1	75	5	1	1
	Emerald shiner	1	65	3		
1050-1450	Gizzard shad	10	57-162	96	10	10
	Carp	1	428	796	1	1
	Emerald shiner	1	79	5	1	1
	Minnow (Cyprinidae)	1	91	8	1	1
	Spotted bass	1	124	23	1	1
	Freshwater drum	1	78	6		
1450-1850	Gizzard shad	10	75-158	90	10	1
	Emerald shiner	1	50	1	1	1
	Freshwater drum	1	70	4		
1850-2255	Freshwater drum	10	72-92	52	10	3
	Gizzard shad	3	68-95	22	3	3
	Bluegill	3	32-45	7	1	1
	Channel catfish	1	182	44		

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
October 17 2255-0250	Gizzard shad	25	71-104	205		
	Bluegill	1	124	36	1	
0250-0650	Gizzard shad	30	58-122	218		
	Emerald shiner	2	52-78	5		2
	Bluntnose minnow	1	92	10	1	
	Channel catfish	1	73	4		1
	Flathead catfish	1	110	12	1	
	Bluegill	1	45	4		1
0650-1050	Gizzard shad	23	52-140	196		
	Emerald shiner	1	76	4		1
	Freshwater drum	1	80	7		1
	Minnow (Cyprinidae)	1	27	7		1
	Bluegill	1	62	5		1
	Sunfish (<u>Micropodus</u>)	1	115	18	1	
October 23 0630-1050	Emerald shiner	1	71	4		1
1050-1450	Gizzard shad	1	70	8		1
	Channel catfish	1	96	10		1
1450-1850	Spotted bass	1	128	23		1
1850-2250	Gizzard shad	1	101	8		1

TABLE 1 (Continued)

<u>Date & Time</u>	<u>Taxon</u>	<u>Number</u>	<u>Total Length Range (mm)</u>	<u>Weight (g)</u>	<u>Alive</u>	<u>Dead</u>
<u>October 24</u> <u>2250-0250</u>	Gizzard shad	2	65-86 59	9	2	1
	Emerald shiner	1		2		
<u>0250-0720</u>	Gizzard shad	5	72-114	40	2	5
	Channel catfish	2	89-181	61	1	1
	Spotted bass	1	56	4		
	Emerald shiner	1	60	4		
<u>0720-1050</u>		1				

TABLE 1 (Continued)

Date & Time 1978	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
December 4 0645-1130	Gizzard shad	131	57-218	878		
	Bluegill	4	53-130	40	3	1
	White bass	3	108-116	38		3
	Freshwater drum	2	80-84	9		2
	Emerald shiner	1	85	3		1
	Silver redhorse	1	270	243		1
	Channel catfish	1	210	50		1
	Quillback	1	388	621		1
	Sunfish (<i>Lepomis</i>)	1	45	2		1
1130-1530	Gizzard shad	44	55-193	572		44
	Freshwater drum	4	81-90	23		4
	Bluegill	3	38-96	18		2
	Emerald shiner	1	85	4		1
1530-1850	Gizzard shad	11	53-200	156		11
	Bluegill	1	65	4		1
	Freshwater drum	1	85	8		1
1850-2250	Gizzard shad	2	73-163	54		1
December 5 2250-0240	Gizzard shad	2	65-135	32		2
	Bluegill	1	54	6		1
0240-0655	Gizzard shad	17	57-170	80		17

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
December 18 0630-1050	Gizzard shad	20	58-181	233		20
	Freshwater drum	1	62	6		1
1050-1450	Gizzard shad	23	62-177	371		23
	Silver redhorse	1	288	246		
	Channel catfish	1	72	4		
	Sunfish (<i>Lepomis</i>)	1	116	28		1
1450-1850	Gizzard shad	18	60-157	178		18
	White crappie	1	64	3		1
1850-2250	Gizzard shad	13	59-187	121		13
	Emerald shiner	1	72	4		1
December 19 2250-0250	Gizzard shad	11	60-158	136		11
	Emerald shiner	1	80	3		1
	Silver redhorse	1	316	370		1
0250-0650	Gizzard shad	8	56-181	107		8
	Silver redhorse	1	375	568		
	Largemouth bass	1	267	240		1
0650-1050	Gizzard shad	5	62-142	43		5
	Freshwater drum	1	90	8		1

C
W

TABLE 1 (Continued)

Date & Time <u>1979</u>	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
January 8 0700-1120	Channel catfish	3	68-86	11	2	1
	Gizzard shad	2	155-169	79	2	
	Golden redhorse	2	246-315	543	1	1
	Goldfish	1	240	282	1	1
	Emerald shiner	1	58	2		
	White catfish	1	168	57	1	
	Flathead catfish	1	122	19	1	
	Black crappie	1	93	11		
	Darter (Percidae)	1	67	3	1	
1120-1520	Gizzard shad	1	168	44 ^b	1	
	Channel catfish	1		108 ^b	1	
1520-1915	Channel catfish	2	193-377	536	2	
1915-2320	Channel catfish	1	235	98	1	
January 9 2320-0220	Unable to Sample ^c					
0220-0620	Unable to Sample					
0620-1020	Unable to Sample					
January 22 0725-1125	Gizzard shad	3	148-172	131	3	
1125-1525	Channel catfish	1		82	6	1
1525-1915	No fish collected					
1915-2320	No fish collected					

TABLE 1 (Continued)

<u>Date & Time</u>	<u>Taxon</u>	<u>Number</u>	<u>Total Length Range (mm)</u>	<u>Weight (g)</u>	<u>Alive</u>	<u>Dead</u>
January 22 2320-0320	No fish collected					
0320-0715	Channel catfish	2	77-93	7		
	Gizzard shad	1	144	26	2	1
0715-1120	No fish collected					

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
<u>February 5</u> <u>1979</u>						
0645-1055	No fish collected					
1055-1455	No fish collected					
1455-1855	No fish collected					
1855-2255	No fish collected					
<u>February 6</u> <u>2255-0255</u>	No fish collected					
0255-0650	No fish collected					
0650-1055	Gizzard shad	3	128-150	78	3	
<u>February 19</u> <u>0630-1050</u>	No fish collected					
1050-1450	No fish collected					
1450-1850	No fish collected					
1850-2250	No fish collected					
<u>February 20</u> <u>2250-0300</u>	Silver chub	1		91	5	1
	Emerald shiner	1		84	4	1
0300-0650.	No fish collected					
0650-1050	No fish collected					

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
March 5 0450-0850	Emerald shiner Sucker (Catostomidae)	1 1	81 108	6 14	1	1
0850-1250	Channel catfish	2	85-132	15		2
1250-1700	Redhorse (<i>Moxostoma</i>) Channel catfish	1 1	221 100	114 12	1 1	
1700-2105	Channel catfish	1	82	4	1	
March 6 2105-0050	No fish collected					
0050-0450	No fish collected					
0450-0900	No fish collected					
March 19 0720-1120	No fish collected					
1120-1520	No fish collected					
1520-1920	No fish collected				1	
1920-2320	Gizzard shad	1	184	62		
March 20 2320-0320	No fish collected				1	
0320-0720	Channel catfish Emerald shiner	1 1	65 84	2 4	1 1	
0720-1120	Golden redhorse	1	317	355		

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
March 26 1979	No fish collected					
0710-1120	No fish collected					
1120-1520	No fish collected					
1520-1920	Sauger	1		247	111	1
1920-2320	No fish collected					
March 27 2320-0320	No fish collected					
0320-0720	No fish collected					
0720-1120	No fish collected					
April 2 0720-1120	Channel catfish	1		89	4	1
	Sauger	1		252	124	1
1120-1520	No fish collected					
1520-1920	Rock bass	1		54	2	1
1920-2320	Bluntnose minnow	1		92	6	1
	Channel catfish	1		338	258	1
	Emerald shiner	1		79	5	1
April 3 2320-0320	Channel catfish	2		83-88	8	1
	Emerald shiner	1		82	5	1
	Golden redhorse	1		306	299	1
0320-0715	Channel catfish	4		73-85	20	2
0715-1120	Emerald shiner	1		46	1	1
	Sauger	1		281	192	

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
1979 <u>April 9</u> 0650-1050	No fish collected	1	65	1		1
1050-1450	Emerald shiner	1	360	382	1	
1450-1850	Sauger	1	300	224	1	
1850-2250	Sauger	1	310	242	1	
<u>April 10</u> 2250-0250	Sauger	1				
0250-0650	No fish collected					
0650-1050	No fish collected					
<u>April 16</u> 0650-1050	No fish collected					
1050-1450	No fish collected					
1450-1850	No fish collected				1	
1850-2250	Golden redhorse	1	324	410		
<u>April 17</u> 2250-0250	No fish collected					1
0250-0650	White crappie	1	93	4		
0650-1050	Golden redhorse	1	322	418		
<u>April 23</u> 0730-1030	Emerald shiner	1	75	3		
	Northern hog sucker	1	159	36	1	1
	Silver redhorse	1	229	134		1
	White crappie	1	92	8		

TABLE 1 (Continued)

Date & Time	Taxon	Number	Total Length Range (mm)	Weight (g)	Alive	Dead
April 23 1030-1430	White crappie Silver redhorse	3 1	84-94 330	21 348	1	3
1430-1830	White crappie	1	91	9	1	1
1830-2230	No fish					
April 24 2230-0230	Bluegill Trout perch White crappie	1 1 1	162 75 96	78 5 8	1 1 1	1
0230-0630	Channel catfish Golden redhorse Trout perch	1 1 1	176 292 89	38 280 8	1 1 1	1
0630-1030	White crappie Bluegill Emerald shiner	2 1 1	87-91 117 73	14 24 3	1 1 1	1
April 30 0630-1030	White crappie	1	100	9	1	1
1030-1430	White crappie	1	90	8	1	1
1430-1830	No sample					
1830-2230	White crappie	3	81-92	14	3	3
May 1 2230-0230	White crappie Black crappie White crappie Bluntnose minnow Emerald shiner	4 1 5 1 1	82-90 223 75-98 79 75	15 130 23 5 4	4 1 5 1 4	7
0230-0650	White crappie	7	87-104	63		

TABLE 2

NUMBERS OF FISH IMPINGED AT THE KAMMER PLANT
CONSIDERED DEAD PRIOR TO BECOMING IMPINGED

<u>Date and Time</u>	<u>Taxon</u>	<u>Number</u>
<u>May 8, 1978</u>		
0800-1505	White Crappie	1
1505-1930	White Bass	1
1930-2315	Emerald shiner	1
<u>May 9</u>		
0330-0800	Channel catfish	1
	Smallmouth bass	1
	Minnow (Cyprinidae)	1
<u>May 15</u>		
0700-1430	Emerald shiner	7
1430-1830	Emerald shiner	3
1830-2330	White crappie	1
<u>May 16</u>		
0230-0645	Emerald shiner	1
	Channel catfish	1
0645-1037	Emerald shiner	5
	Channel catfish	1
<u>May 22</u>		
1150-1550	Redhorse (<u>Moxostoma</u>)	1
	Black crappie	1
1550-2000	Channel catfish	1
2000-2400	Emerald shiner	3
<u>May 29</u>		
1130-1520	Emerald shiner	1
	Channel catfish	2
<u>May 30</u>		
2020-0020	Emerald shiner	4
0020-0420	Emerald shiner	2

TABLE 2 (Continued)

<u>Date and Time</u>	<u>TAXON</u>	<u>Number</u>
0420-0820	Silver redhorse	1
	Sauger	1
0820-1220	Carp	1
	Total	43
<u>June 5, 1978</u>		
0730-1120	Emerald shiner	1
1120-1520	Sunfish (<u>Lepomis</u>)	1
<u>June 12</u>		
0730-1200	Emerald shiner	2
	Catfish (<u>Ictalurus</u>)	1
	Sauger	1
<u>June 19</u>		
1120-1520	Bluegill	1
	Total	7
<u>July 10, 1978</u>		
0940-0955	Carp	2
	Pumpkinseed	1
<u>July 11</u>		
2200-0150	Carp	1
0150-0550	Gizzard shad	1
<u>July 24</u>		
0700-1120	Sauger	1
1520-1920	Carp	1
1920-2320	Silver redhorse	1
<u>July 25</u>		
0330-0720	Catfish (<u>Ictalurus</u>)	1

TABLE 2 (Continued)

<u>Date and Time</u>	<u>Taxon</u>	<u>Number</u>
<u>July 31</u>		
0300-0820	Gizzard shad	1
0820-1220	Catfish (<i>Ictalurus</i>)	1
	Emerald shiner	1
	Unidentifiable	1
	Total	13
<u>August 7, 1978</u>		
0700-1120	Unidentifiable	2
<u>August 8</u>		
2320-0320	Carp	1
<u>August 14</u>		
0730-1150	Gizzard shad	1
1150-1550	Channel catfish	1
1550-1945	Carp	1
<u>August 22</u>		
0650-1050	White crappie	1
<u>August 28</u>		
0630-1050	Gizzard shad	6
1050-1450	Gizzard shad	2
	Channel catfish	1
1450-1850	Channel catfish	2
	Gizzard shad	1
1850-2300	Channel catfish	3
	Yellow bullhead	1
	Gizzard shad	1
	Smallmouth bass	1
	Freshwater drum	1

TABLE 2 (Continued)

<u>Date and Time</u>	<u>Taxon</u>	<u>Number</u>
<u>August 29</u>		
2300-0300	Channel catfish	2
0300-0650	Channel catfish	5
0650-1050	Channel catfish	1
	Total	34
<u>September 4, 1978</u>		
0330-0755	Channel catfish	4
	Freshwater drum	1
0755-1150	Trout-perch	1
1150-1550	Gizzard shad	3
	Emerald shiner	1
1550-1950	Channel catfish	1
	Redhorse (<i>Moxostoma</i>)	1
1950-2350	Gizzard shad	2
<u>September 5</u>		
2350-0350	Gizzard shad	12
	Channel catfish	1
	Pumpkinseed	1
	Freshwater drum	1
0350-0750	Channel catfish	1
<u>September 11</u>		
0630-1100	White crappie	1
<u>September 12</u>		
0300-0700	Sunfish (Centrarchidae)	1
0700-1100	Channel catfish	2
<u>September 18</u>		
1050-1450	Carp-	1
1450-1850	Channel catfish	1
1850-2250	Channel catfish	3
	Gizzard shad	1

TABLE 2 (Continued)

<u>Date and Time</u>	<u>Taxon</u>	<u>Number</u>
<u>September 19</u>		
2250-0250	Channel catfish	1
0250-0650	Gizzard shad	2
	Emerald shiner	2
	Channel catfish	1
	Golden redhorse	1
<u>September 25</u>		
0630-1050	Gizzard shad	5
	Herring (Clupeidae)	1
	Channel catfish	1
1050-1450	Gizzard shad	7
1450-1850	Gizzard shad	1
1850-2250	Emerald shiner	3
	Gizzard shad	2
<u>September 26</u>		
2250-0250	Gizzard shad	2
	Minnow (Cyprinidae)	1
	Channel catfish	1
0250-0650	Unidentifiable	2
0650-1050	Channel catfish	1
	Minnow (Cyprinidae)	1
	Total	75
<u>October 2, 1978</u>		
0630-1050	Gizzard shad	1
	Emerald shiner	1
<u>October 3</u>		
0240-0650	Minnow (Cyprinidae)	1
	Channel catfish	1
<u>October 9</u>		
0630-1050	Gizzard shad	1
1850-2250	Gizzard shad	2

TABLE 2 (Continued)

<u>Date and Time</u>	<u>Taxon</u>	<u>Number</u>
<u>October 10</u>		
2250-0250	Channel catfish	1
0250-0650	Minnow (Cyprinidae)	1
0650-1050	Channel catfish	1
<u>October 16</u>		
0630-1050	Freshwater drum	4
	Minnow (Cyprinidae)	1
	Channel catfish	1
	Catfish (<i>Ictalurus</i>)	1
1850-2255	Gizzard shad	5
	Channel catfish	1
<u>October 17</u>		
2255-0250	Freshwater drum	3
0250-0650	Sunfish (Centrarchidae)	1
0650-1050	Emerald shiner	1
	Freshwater drum	1
	Herring (Clupeidae)	1
	Channel catfish	1
<u>October 23</u>		
0630-1050	Gizzard shad	2
	Herring (Clupeidae)	1
	Channel catfish	1
1050-1450	Gizzard shad	1
	Sauger	1
1850-2250	Emerald shiner	1
	Sunfish (Centrarchidae)	1
<u>October 24</u>		
2250-0250	Herring (Clupeidae)	1
	Channel catfish	1
	Bluegill	1
0250-0720	Emerald shiner	1
	Catfish	1
0720-1050	Gizzard shad	2
	Channel catfish	1
	Total	47

TABLE 2 (Continued)

<u>Date and Time</u>	<u>Taxon</u>	<u>Number</u>
<u>November 6, 1978</u>		
0630-1050	Gizzard shad	1
1050-1450	Gizzard shad	1
1450-1850	Channel catfish	2
1850-2250	Gizzard shad	2
<u>November 7</u>		
0650-1050	Gizzard shad	1
	Channel catfish	2
	Sunfish (Centrarchidae)	1
<u>November 20</u>		
0650-1050	Gizzard shad	48
	Herring (Clupeidae)	14
1050-1450	Gizzard shad	40
	Herring (Clupeidae)	20
1450-1850	Gizzard shad	31
	Herring (Clupeidae)	26
1850-2130	Gizzard shad	80
	Herring (Clupeidae)	3
2130-0250	Gizzard shad	17
0250-0650	Gizzard shad	10
	Herring (Clupeidae)	1
0650-1050	Gizzard shad	5
	Total	305
<u>December 4, 1978</u>		
0645-1130	Gizzard shad	35
	Redhorse (<u>Moxostoma</u>)	1
1530-1850	Gizzard shad	2
1850-2250	Gizzard shad	1
<u>December 5</u>		
2250-0245	Gizzard shad	1
0245-0655	Gizzard shad	1
<u>December 18</u>		
0630-1050	Gizzard shad	7

TABLE 2 (Continued)

<u>Date and Time</u>	<u>Taxon</u>	<u>Number</u>
1050-1450 1450-1850 1850-2250	Herring (Clupeidae)	4
	Minnow (Cyprinidae)	1
	Sunfish (<u>Micropterus</u>)	1
	Gizzard shad	13
	Gizzard shad	7
	Channel catfish	1
December 19	Gizzard shad	2
2250-0250	Channel catfish	1
0250-0650	Gizzard shad	8
0650-1050	Herring (Clupeidae)	1
	Gizzard shad	4
	Herring (Clupeidae)	1
	Freshwater drum	1
	Total	95
January 8, 1979		
1520-1915	Gizzard shad	1
	Black crappie	1
January 22		
0725-1125	Gizzard shad	1
	Total	3
April 3, 1979		
0715-1120	Redhorse (<u>Moxostoma</u>)	1
April 23		
0730-1030	Goldfish	1
1030-1430	Crappie (<u>Pomoxis</u>)	1
1430-1830	Unidentifiable	1
1830-2230	Sucker (Catostomidae)	1
	Sucker (Catostomidae)	1

TABLE 2 (Continued)

<u>Date and Time</u>	<u>Taxon</u>	<u>Number</u>
2230-0230	Carp	1
0630-1030	Sunfish (<u>Lepomis</u>)	1
	White crappie	1
<u>April 30</u>		
1030-1430	White crappie	1
0250-0650	White crappie	1
0650-1050	White crappie	14
	Minnow (Cyprinidae)	3
	Channel catfish	1
	Sunfish (<u>Lepomis</u>)	1
		<hr/>
	Total	30

APPENDIX B
KAMMER PLANT
PLANT OPERATING AND FIELD DATA

<u>Table</u>	<u>Title</u>
1	INTAKE (I) AND DISCHARGE (D) WATER TEMPERATURE (F) DATA, KAMMER PLANT
2	AIR TEMPERATURE ($^{\circ}$ F) AND BAROMETRIC PRESSURE (in. of Hg) DATA, KAMMER PLANT
3	WIND DIRECTION (D) SPEED (S) (mph) AND PERCENT CLOUD COVER (% CC), KAMMER PLANT
4	CHLORINATION DATA, KAMMER PLANT
5	RIVER ELEVATION DATA (FT ABOVE MEAN SEA LEVEL) DATA, KAMMER PLANT
6	KAMMER PLANT UNIT OUTAGES

TABLE I
INTAKE (I) AND DISCHARGE (D) WATER TEMPERATURE ($^{\circ}\text{F}$)
KAMMER PLANT

Date: Unit: Time	MARCH 1978												APRIL 1978													
	13												20												27	
	1	D	1	D	1	D	1	D	1	D	1	D	1	D	1	D	1	D	1	D	1	D	1	D		
0800																										
0800	41	57	00S		00S		39	46	00S		00S		00S		44	44	00S		00S		44	44	00S			
1200	41	56	00S		00S		40	46	00S		00S		00S		45	52	00S		00S		45	52	00S			
1600	42	58	00S		00S		41	46	00S		00S		00S		43	50	00S		00S		43	50	00S			
2000	42	56	00S		00S		40	43	00S		00S		00S		44	52	00S		00S		43	51	00S			
2400	41	59	00S		00S		40	43	00S		00S		00S		44	43	00S		00S		43	50	00S			
0400	41	62	00S		00S		40	48	00S		00S		00S		45	43	00S		00S		43	50	00S			
0800																										
Date: Unit: Time	10												17												24	
	1	D	1	D	1	D	1	D	1	D	1	D	1	D	1	D	1	D	1	D	1	D	1	D		
	48	59	00S		51	62	00S		54	63	53	63	00S		54	64	00S		54	64	00S		54	64	00S	
0800	49	59	00S		52	62	00S		54	64	54	66	00S		52	64	00S		54	64	00S		54	64	00S	
1200	48	59	00S		52	63	00S		56	66	56	66	00S		54	64	00S		54	64	00S		54	64	00S	
1600	48	59	47	58	00S	52	62	51	62	00S	56	65	00S		54	64	00S		54	64	00S		54	64	00S	
2000	47	59	47	58	00S	52	61	50	58	00S	54	64	00S		53	63	00S		53	63	00S		54	64	00S	
2400	48	59	00S		52	62	50	61	00S	54	64	53	64	00S		54	64	00S		54	64	00S		54	64	00S
0400	49	58	00S		52	63	00S		54	65	54	65	00S		53	64	00S		53	64	00S		54	64	00S	

OOS - Unit out of service

^aTemperature recorder not functioning

b System being back-flushed

TABLE 1 (Continued)

Date: Time: Unit:	1			2			3			8			15			22			29									
	1			2			1			2			1			2			1									
	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D						
0800	56	64	68	65	58	68	59	70	00S	61	70	58	69	60	72	60	70	70	67	00S	66	80	64	76				
1200	56	65	57	68	54	66	59	70	00S	62	70	62	74	58	70	60	72	60	72	68	69	00S	66	78	64	75		
1600	56	66	56	66	56	66	60	70	00S	61	61	50	62	54	69	61	72	60	72	58	70	00S	67	79	64	73		
2000	56	65	56	67	54	65	59	69	59	70	00S	60	70	60	72	57	67	60	72	61	72	00S	68	78	64	75		
2400	57	65	57	66	54	65	60	69	59	70	00S	60	72	60	72	58	68	61	71	60	72	58	69	00S	69	78	76	71
0400	57	63	57	66	54	63	59	68	59	70	00S	60	65	60	72	60	69	60	71	61	66	58	69	00S	67	78	64	76
0800	56	66	57	66	53	65	59	68	59	70	00S	60	71	60	72	58	68	61	72	61	72	58	69	00S	68	78	64	77
1200	-	-	-	-	-	-	59	69	59	70	00S	60	71	60	70	56	70	61	72	61	69	57	68	00S	68	79	65	77
JUNE 1978																												
Date: Time: Unit:	5			12			19			26			1			2			3			1			2			
	1			2			1			2			1			2			1			2						
	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D				
0800	73	82	73	84	70	80	00S	00S	(a)	00S	75	88	75	88	00S	76	90	76	89	00S	78	87	78	88				
1200	73	83	73	84	69	90	00S	00S	73	88	00S	76	87	76	90	00S	79	90	80	90	00S	78	89	80	92			
1400	73	84	73	84	70	82	00S	00S	73	88	00S	77	88	77	89	00S	79	90	80	93	00S	79	90	79	92			
2000	74	84	74	85	70	80	00S	00S	73	87	00S	77	88	77	90	00S	79	90	79	92	00S	78	86	78	91			
2400	74	83	73	85	70	82	00S	00S	72	87	00S	76	87	76	89	00S	78	86	78	91	00S	78	86	78	90			
0400	74	82	73	83	70	81	00S	00S	70	77	00S	76	87	77	86	00S	78	89	78	90	00S	79	89	79	91			
0800	74	84	73	84	70	80	00S	00S	76	88	00S	76	88	76	88	00S	79	89	79	91	00S	79	89	79	91			
1200	74	84	73	84	70	83	00S	00S	76	88	00S	76	88	76	88	00S	79	89	79	91	00S	79	89	79	91			

TABLE 1 (Continued)

		JULY 1978						AUGUST 1978						
		10			17			24			31			
		1		D	1		D	1		D	1		D	
Date:	Unit:	1	D	2	1	D	2	1	D	2	1	D	2	
Time:		1	D	2	1	D	2	1	D	2	1	D	2	
0000	00S	79	86	80	87	00S	76	88	00S	76	85	76	85	
0400	00S	78	90	79	91	00S	76	87	78	89	77	88	78	
0800	00S	78	90	79	90	00S	76	87	76	88	79	88	79	
1200	00S	78	90	78	90	00S	76	84	75	86	79	88	79	
1600	00S	78	90	78	90	00S	76	83	76	84	79	88	79	
2000	00S	78	90	78	90	00S	76	84	00S	79	88	78	89	
2400	00S	77	84	78	84	00S	76	83	00S	76	84	77	86	
00400	00S	77	82	77	83	00S	75	87	00S	76	87	76	89	
0800	00S	77	87	78	89	00S	75	87	00S	76	87	76	89	
1200	00S	77	87	78	89	00S	75	87	00S	76	87	76	89	
		JULY 1978						AUGUST 1978						
		14			21			28			31			
		1		D	1		D	1		D	1		D	
Date:	Unit:	1	D	2	1	D	2	1	D	2	1	D	2	
Time:		1	D	2	1	D	2	1	D	2	1	D	2	
0800	00S	81	92	78	90	00S	74	86	82	90	00S	81	93	82
1200	00S	82	93	78	91	00S	74	87	82	90	00S	81	93	83
1600	00S	82	92	78	91	00S	74	88	82	91	00S	81	93	84
2000	00S	82	92	79	92	00S	74	87	82	91	00S	81	93	83
2400	00S	82	94	78	90	00S	75	87	82	93	00S	81	92	82
0400	00S	82	92	78	90	00S	75	88	82	90	00S	81	93	82
0800	00S	81	93	77	91	00S	75	88	72	87	00S	82	93	82
1200	00S	82	93	78	91	00S	75	88	72	87	00S	82	93	82

TABLE 1 (Continued)

Date: Unit:	4			11			18			25		
	2			1			1			1		
	I	D	1	D	1	D	I	D	1	D	1	D
Time												
0800	80	88	00S	75	83	82	92	00S	80	90	79	90
1200	80	90	00S	75	87	82	93	00S	80	91	79	89
1600	80	90	00S	75	87	82	93	00S	81	92	79	92
2000	80	90	00S	75	85	83	94	00S	82	92	80	91
2400	80	90	00S	74	93	81	92	00S	82	92	80	92
0400	79	87	00S	74	81	82	91	00S	82	92	79	90
0800	78	87	00S	73	85	82	92	00S	82	92	78	90
1200												
Date: Unit:	2			9			16			23		
	1			1			1			1		
	I	D	1	D	1	D	I	D	1	D	1	D
Time												
0800	77	82	00S	69	82	72	81	00S	68	78	69	74
1200	77	87	00S	69	81	71	82	69	73	68	74	62
1600	77	88	00S	68	80	72	82	68	80	69	88	64
2000	73	88	00S	76	80	72	81	68	79	67	88	64
2400	76	87	00S	66	80	71	80	66	77	65	80	68
0400	82	85	00S	80	83	70	77	67	73	65	80	66
0800	76	87	00S	69	80	71	81	68	70	66	74	67
1200	77	86	00S	69	80	72	81	67	78	66	79	67

TABLE 1 (Continued)

NOVEMBER 1978				DECEMBER 1978			
Date:		6		20		16	
Time	Unit:	1	D	1	D	1	D
0800	61	71	59	68	00S	00S	54
1200	62	72	59	78	00S	00S	54
1600	62	72	69	78	00S	00S	55
2000	62	73	59	69	00S	00S	55
2400	62	72	60	68	00S	00S	56
0400	61	72	58	68	00S	00S	56
0800	61	72	59	68	00S	00S	56
1200	61	74	59	63	00S	00S	56

NOVEMBER 1978				DECEMBER 1978			
Date:		6		20		16	
Time	Unit:	1	D	1	D	1	D
0800	48	59	48	59	46	58	41
1200	48	59	48	59	46	63	52
1600	49	59	45	58	46	64	52
2000	49	58	48	59	47	65	52
2400	47	58	47	61	46	64	46
0400	47	58	48	55	47	64	51
0800	47	58	47	58	45	55	51
1200	47	58	46	58	44	63	51

TABLE 1 (Continued)

Date: 0001:	Time: 0000	JANUARY 1979			FEBRUARY 1979		
		1	2	3	1	2	3
1200	36 46	00S	34 44		00S	36 47	36 48
1600	36 47	00S	34 47		00S	36 47	36 49
2000	36 48	00S	34 46		00S	36 47	36 49
2400	39 47	00S	33 47		00S	36 46	36 47
0000	35 44	00S	33 47		00S	36 46	36 47
0400	35 46	00S	33 47		00S	36 47	36 46
0800	35 46	00S	32 45		37 49	36 47	36 47
1200							
Date: 0001:	Time: 0400	JANUARY 1979			FEBRUARY 1979		
		1	2	3	1	2	3
1200	37 49	36 47	36 48		35 47	34 45	35 47
1600	37 49	36 47	36 49		35 47	35 45	35 48
2000	37 49	37 47	36 49		36 47	36 47	34 48
2400	37 49	36 45	36 48		35 48	35 45	35 48
0000	36 44	36 45	36 48		35 48	34 46	35 37
0400	36 48	36 46	34 46		35 47	34 45	35 48
0800	36 48	35 46	35 47		36 48	34 45	35 48
1200							

TABLE 1 (Continued)

Date: Unit:	MARCH 1979												
	5				12				19				
	1	D	1	D	1	D	1	D	1	D	1	D	
0000	008	42	53	42	57	45	56	008	43	56	51	62	
1200	43	56	42	53	43	57	45	56	008	43	56	51	61
1600	45	56	42	52	42	58	46	56	008	44	57	51	62
2000	45	56	43	56	43	57	46	56	008	44	57	50	61
2400	45	56	43	53	42	55	46	51	008	44	57	50	61
0400	43	56	42	53	43	57	46	51	008	44	56	50	61
0800	43	53	42	53	42	56	46	53	008	44	57	50	61
1200							46	57	008	45	57	50	61

Date: Unit:	APRIL 1979												
	9				16				23				
	1	D	1	D	1	D	1	D	1	D	1	D	
0000	008	49	61	49	61	50	62	48	61	008	52	64	
1200	51	51	49	61	50	61	50	62	48	61	008	52	64
1600	51	61	50	61	50	62	50	62	48	61	008	52	64
2000	52	62	50	62	50	62	50	61	48	61	008	52	63
2400	52	63	49	61	52	60	48	60	47	60	008	52	63
0400	52	62	51	61	50	60	50	61	47	57	008	52	59
0800	51	62	49	61	50	61	49	61	47	60	008	52	60
1200	52	63	50	61	50	61	50	61	47	60	008	52	64

TABLE 2
AIR TEMPERATURE ($^{\circ}$ F) AND BAROMETRIC PRESSURE (in of Hg) DATA
KAMMER PLANT

Time	MARCH 1978					
	Date:		13		20	
	Temp	BP	Temp	BP	Temp	BP
0800			45	29.49	40	29.66
1200			29.38	59	29.53	52
1600			29.27	68	29.40	46
2000			29.06	55	29.46	44
2400			28.87	50	29.29	42
0400	45	28.87	53	29.25	42	29.39
0800	53	28.87	60	29.18	50	29.41

Time	APRIL 1978					
	Date:		10		17	
	Temp	BP	Temp	BP	Temp	BP
0800	45	29.61	50	29.29	35	29.60
1200	45	29.56	77	29.18	57	29.54
1600	52	29.49	84	29.09	55	29.48
2000	29.53	74	29.09	52	29.45	63
2400	29.50	65	29.08	44	29.5	58
0400	50	29.47	60	28.99	42	29.4
0800	55	29.45	65	68.91	50	29.29
1200					51	29.39

^aBarometric pressure

TABLE 2 (Continued)

TABLE 2 (Continued)

		JULY 1978				AUGUST 1978			
		10		17		24		31	
Date:	Temp	BP	Temp	BP	Temp	BP	Temp	BP	
Time									
0800	66	29.07	74	29.35	65	29.34	72	29.57	68
1200	70	29.09	80	29.33	71	29.34	73	29.57	68
1600	72	29.12	80	29.30	80	29.37	75	29.55	69
2000	69	29.16	72	29.39	86	29.34	74	29.52	68
2400	65	29.18	70	29.42	74	29.37	70	29.50	68
0400	64	29.22	57	29.50	64	29.43	70	29.46	64
0800	29.30		29.50		63	29.48	72	29.47	68
1200	29.34				62	29.49	79	29.44	
0800	69	29.51	70	29.50	60	29.65	70	29.33	
1200	75	29.46	81	29.54	67	29.68	75	29.31	
1600	78	29.43	86	29.45	78	29.60	84	29.22	
2000	74	29.45	73	29.45	69	29.58	82	29.22	
2400	67	29.48	70	29.46	58	29.56	75	29.21	
0400	66	29.55	69	29.46	58	29.55	68	29.21	
0800	66	29.57	81	29.50	29.57	72	29.39		
1200	72						74	29.34	

TABLE 2 (Continued)

Time	SEPTEMBER 1978										OCTOBER 1978									
	4					11					18					25				
	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP
0800	62	29.39	67	29.37	67	29.44	56	29.51												
1200	68	29.41	72	29.38	74	29.44	60	29.51												
1600	77	29.41	84	29.28	83	29.43	78	29.52												
2000	70	29.42	77	29.28	73	29.40	60	29.52												
2400	62	29.43	75	29.29	73	29.47	53	29.63												
0400	60	29.41	70	29.26	72	29.47	50	29.50												
0800	56	29.45	66	29.27	70	29.49	46	29.63												
1200			74	29.28	75	29.56	54	29.64												
0800	44	29.52	31	29.68	29.33	40	29.42													
1200	46	29.50	40	29.72	35	29.34	48	29.43												
1600	52	29.47	50	29.64	38	29.38	50	29.39												
2000	50	29.43	48	29.63	38	29.48	45	29.49												
2400	36	29.45	38	29.64	38	29.57	40	29.58												
0400	38	29.38	33	29.67	38	29.67	34	29.59												
0800	40	29.35	34	29.64	36	29.71	33	29.60												
1200	44	29.39	42	29.67	38	29.78	34	29.64												

TABLE 2 (Continued)

Time	NOVEMBER 1978						DECEMBER 1978					
	6		20		18		4		18		18	
	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP
0800	35	29.47			27	29.88						
1200	46	29.48			30	29.9						
1600	64	92.35			42	29.81						
2000	50	29.35			34	29.80						
2400	43	29.39			30	29.80						
0400	45	29.35			31	29.77						
0800	40	29.37			31	29.77						
1200	39	29.42			34	29.82						
0800	53	28.89			32	29.60						
1200		29.80			36	29.54						
1600		29.07			38	29.36						
2000		29.11			38	29.38						
2400		29.04			36	29.37						
0400		29.09			34	29.40						
0800		29.02			30	29.38						
1200		29.23			32	29.45						

TABLE 2 (Continued)

Time	Date: 8			JANUARY 1979			Date: 22		
	Temp	BP	Temp	BP	Temp	BP	Temp	BP	
0800	21	29.43			28	29.60			
1200	23	29.47			30	29.31			
1600	22	29.50			33	29.31			
2000	9	29.64			30	29.40			
2400	6	29.72			29	29.43			
0400	3	29.74			29	29.40			
0800	5	29.72			24	29.36			
1200	8	29.74			30	29.31			

Time	Date: 5			FEBRUARY 1979			Date: 9		
	Temp	BP	Temp	BP	Temp	BP	Temp	BP	
0800	3	29.66			18	29.72			
1200	8	29.68			23	29.83			
1600	13	29.52			29	29.84			
2000	15	29.62			24	29.88			
2400	7	29.64			15	29.84			
0400	5	29.63			10	29.86			
0800	2	29.62			7	29.86			
1200	11	29.64			18	29.83			

TABLE 2 (Continued)

MARCH 1979						APRIL 1979						
Date:	5		19		26		2		9		16	
Time	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP
0800	46	29.45			39	29.60	28					
1200	46	29.45			54	29.56	31					
1600	46	29.46			58	29.49	32					
2000	42	29.46			51	29.50	34					
2400	42	29.50			47	29.52	34					
0400	40	29.47			47	29.47	34					
0800	39	29.45			37	29.49	35					
1200					50	29.51	37					
Date:	2		9		16		23		30		30	
Time	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP	Temp	BP
0800	58	29.58	49	28.74	42	29.44	52					
1200	60	29.59	40	28.78	46	29.46	62					
1600	67	29.19	34	28.96	48	29.43	68					
2000	64	29.24	36	29.13	46	29.44	64					
2400	53	29.40	36	29.23	44	29.50	56					
0400	48	29.44	34	29.30	42	29.49	54					
0800	46	29.58	32	29.39	43	29.53	55					
1200	47	29.62	42	29.47	51	29.59	70					

TABLE 3

WIND DIRECTION (D) SPEED (S) (mph) AND PERCENT CLOUD COVER (% CC)
KAMMER PLANT

Date:	MARCH 1978					
	13			20		
	Wind	D	S	Wind	D	S
Time	% CC			% CC		
0800				0-5	0	S
1200				5	50	3
1600	SE	10	0	S	50	100
2000	SE	10	W	W	5	100
2400	SE	10	SSE	SSE	5	100
0400	NE	10	100	SE	10	S
0800	NE	100	S	10	50	5
					10-15	10

Date:	APRIL 1978					
	3			10		
	Wind	D	S	Wind	D	S
Time	% CC			% CC		
0800				0-5	20	N
1200	N	5	100	SW	10-15	70
1600	S	5	80	0-5	N	10
2000	S	0-5	100	SE	5-10	0
2400	S	0-5	100	SE	5-10	N
0400	S	0-5	100	SE	5-10	NE
0800	S	5	20	S	5-10	100
1200						

Date:	APRIL 1978					
	17			24		
	Wind	D	S	Wind	D	S
Time	% CC			% CC		
0800				0-5	0	SW
1200	N	5	100	SW	10	0
1600	S	5	80	0-5	N	10
2000	S	0-5	100	SE	5-10	50
2400	S	0-5	100	SE	5-10	0
0400	S	0-5	100	SE	5-10	E
0800	S	5	20	S	5-10	100
1200						

TABLE 3 (Continued)

		MAY 1978						JUNE 1978							
		1			8			15			22				
Date:		Wind	% CC	D	S	Wind	% CC	D	S	Wind	% CC	D	S	Wind	% CC
Time		D	S	D	S	D	S	D	S	D	S	D	S	D	S
0800	N	5-10	0	Calm	0	100	Calm	0	100	N	5	Fog	Calm	0	0
1200	N	5-10	0	Calm	0	100	N	5	100	Calm	0	30	Calm	0	0
1600	N	5-10	0	Calm	0	100	W	5	100	Calm	0	40	Calm	0	0
2000	N	5-10	0	Calm	0	100	Calm	0	100	N	0-5	60	Calm	0	0
2400	N	5-10	0	S	10	50	N	0-5	100	NE	0-5	5	S	0-5	0
0400	N	5-10	0	S	10	50	N	0-5	100	E	0-5	80	S	0-5	0
0800	NW	5-10	0	S	5-10	5	NE	10-15	100	S	5	100	S	0-5	Fog
1200				S	10-15	75	Calm	0	100	S	5	100	S	0-5	100
		MAY 1978						JUNE 1978							
		5			12			19			26				
Date:		Wind	% CC	D	S	Wind	% CC	D	S	Wind	% CC	D	S	Wind	% CC
Time		D	S	D	S	D	S	D	S	D	S	D	S	D	S
0800	N	5	0	W	0-5	5	SW	5	100	SW	5-10	100			
1200				SW	10	60	SW	5	100	SW	5-10	100			
1600	W	5-10	20	S	10	100	Calm	0	40	SW	10-15	80			
2000	S	0-5	5	S	5-10	100	Calm	0	10	SW	10-15	100			
2400	NE	5-10	0	S	0-5	90	Calm	0	0						
0400	E	5-10	0	W	0-5	70	E	0-5	Fog	W	0-5	80			
0800	Calm	0	0	W	5-10	80	Calm	0	Fog	SW	5-10	Fog			
1200	Calm	0	0	NE	5-10	100	S	5-10	45	S	5-10	10			

TABLE 3 (Continued)

Date:	JULY 1978						AUGUST 1978									
	3			10			17			24			31			
	Wind	D	S	Wind	D	S	Wind	D	S	Wind	D	S	Wind	D	S	% CC
Time																
0800	E	0-5	100	SW	5-10	75	NW	0-5	5	SW	5-10	100	S	5-10	100	
1200	E	0-5	100	S	5-10	100	NE	0-5	25	SW	5-10	100	S	0-5	100	
1600	E	0-5	100	SE	5-10	100	N	0-5	30	SW	5-10	100	S	5	100	
2000	E	0-5	100	SE	10	100	NW	5-10	40	SW	10-15	85	N	0-5	95	
2400	E	0-5	100	SE	10	100	NW	5-10	20	E	5	90	N	0-5	100	
0400	E	0-5	100	N	0-5	Fog	SW	10	5	E	0-5	90	NW	0-5	100	
0800	N	0-5	100	N	5-10	10		0-5	Fog	S	5-10	100	NW	0-5	100	
1200	N	5-10	100					0-5	Fog	S	5-10	100				
	JULY 1978						AUGUST 1978									
	7			14			21			28						
	Wind	D	S	Wind	D	S	Wind	D	S	Wind	D	S	Wind	D	S	% CC
	D	S	% CC	D	S	% CC	D	S	% CC	D	S	% CC	D	S	% CC	
0800	S	0-5	100	N	0-5	50	NE	0-5	10	S	0-5	Fog				
1200	S	5-10	100	NW	0-5	20				S	5-10	5				
1600	S	5-10	100	SW	0-5	70	N	0-5	5	NW	5-10	35				
2000	S	5-10	100	SW	0-5	50	N	0-5	5	NW	5	50				
2400	SW	5-10	10	SW	5-10	100	N	5	5	NW	5-10	80				
0400	SW	5-10	60	SW	0-5	100	N	5	Fog	NW	5-10	90				
0800	S	5-10	35	S	0-5	0	S	5-10	70	NW	5-10	60				
1200				SW	0-5	10				NW	5	40				

TABLE 3 (Continued)

TABLE 3 (Continued)

		NOVEMBER 1978						DECEMBER 1978							
		6			20			18			Wind				
Date:	Time	Wind	% CC	Wind	D	S	% CC	Wind	D	S	% CC	Wind	D	S	% CC
	0800	S	5-10	Fog				N	0-5	100					
	1200	SW	0-5	50				N	5-10	50					
	1600	SW	0-5	10				N	0-5	30					
	2000	SW	0-5	5				N	0-5	10					
	2400	S	5-10	100				W	0-5	Fog					
	0400	S	5-10	100				W	0-5	Fog					
	0800	N	5-10	100				N	0-5	20					
	1200	N	0-5	100				N	0-5	100					
		4			Wind			Wind			Wind				
		Wind	% CC	Wind	D	S	% CC	Wind	D	S	% CC	Wind	D	S	% CC
	0800	SE	0-5	100				W	5-10	50					
	1200	W	5-10	70				S	5-10	90					
	1600	W	5-10	95				SW	5-10	100					
	2000	W	5-10	100				SW	5-10	100					
	2400	W	5-10					W	0-5	100					
	0400	W	5-10	5				N	0-5	40					
	0800	W	5-10	0				N	5-10	15					
	1200	W	5-10	0				N	5-10	100					

TABLE 3 (Continued)

Time	JANUARY 1979						JANUARY 1979					
	8			22			Wind			Wind		
	D	S	% CC	D	S	% CC	D	S	% CC	D	S	% CC
0800	NW	0-5	100				SW	5-10	100			
1200	NW	0-5	100				SW	5-10	100			
1600	NW	0-5	40				SW	5-10	100			
2000	NW	5-10	100				W	5-10	90			
2400	NW	0-5	5				W	0-5	85			
0400	NW	0-5	5				W	0-5	100			
0800	SW	5-10	0				E	0-5	40			
1200	S	5-10	60									

Time	FEBRUARY 1979						FEBRUARY 1979					
	5			19			Wind			Wind		
	D	S	% CC	D	S	% CC	D	S	% CC	D	S	% CC
0800	SW	5-10	0				W	0-5	100			
1200	W	5-10	0				W	5-10	100			
1600	W	5-10	10				W	5-10	60			
2000	W	5-10	0				SW	0-5	0			
2400	W	0-5	0				SW	5	0			
0400	O	0	0				SW	0-5	30			
0800	O	0	0				SE	0-5	20			
1200	S	0-5	80				SE	0-5	20			

TABLE 3 (Continued)

Date:	MARCH 1979											
	5				12				19			
	Wind	D	S	% CC	Wind	D	S	% CC	Wind	D	S	% CC
0800	W	0-5	100		N	0-5	95		W	10-15	100	
1200	SW	0-5	100		N	0-5	95		SW	15-20	100	
1600	SW	0-5	100		N	0-5	100		SW	20-25	100	
2000	S	5	50		N	0-5	100		SW	10-15	100	
2400	S	5	100		N	0-5	0		SW	10-15	100	
0400	S	5-10	100		N	0-5	0		SW	5-10	100	
0800	S	5-10	100		E	5-10	10		W	10-15	50	
1200					NE	0-5	0		W	10-15	100	

Date:	APRIL 1979											
	2				9				16			
	Wind	D	S	% CC	Wind	D	S	% CC	Wind	D	S	% CC
0800	SE	10-15	100		SW	5-10	100		W	0-5	100	
1200	S	20-25	100		SW	0-5	100		W	5-10	100	
1600	S	15-20	70		SW	0-5	100		SW	0-5	100	
2000	S	10-15	40		SW	0-5	100		W	0-5	100	
2400	S	10	95		SW	0-5	100		W	0-5	100	
0400	S	10	90		W	0-5	0		W	0-5	100	
0800	NE	0-5	100		NW	0-5	0		W	5-10	80	
1200	N	5-10	100		N	0-5	15		W	5-10	70	

Date:	APRIL 1979											
	23				30				30			
	Wind	D	S	% CC	Wind	D	S	% CC	Wind	D	S	% CC
0800	S	0-5	100		NE	0-5	100		S	0-5	100	
1200	S	0-5	100		NE	0-5	100		S	0-5	100	
1600	S	0-5	100		NE	0-5	100		S	0-5	100	
2000	S	0-5	100		NE	0-5	100		N	0-5	100	
2400	S	0-5	100		NE	0-5	100		Fog	N	0-5	0
0400	S	0-5	100		NE	0-5	100		Fog	N	0-5	0
0800	NE	0-5	100		NE	0-5	100		N	0-5	100	
1200	N	0-5	100		Calm				90			10

TABLE 4

CHLORINATION DATA
KAMMER PLANT

Date Mon/Yr	Day	Unit #1				Unit #2				Unit #3			
		Condensor		Plant		Condensor		Plant		Condensor		Plant	
		Discharge	Free ^a	Total ^b	Free	Discharge	Total	Free	Discharge	Total	Free	Discharge	Total
Mar/78	17	.50		.15		.10		.10		.10		.24	
	22	.70		.2		.10		.10		.10		.05	
	28	1.0	.75	.10	.10	.05		.05		.05		.05	
	31												
Apr/78	3	.00	.40	.05	.05	.00		.00		.05		.25	
	5	.15	.00										
	13												
	15												
	19												
	24												
May/78	26	.00	.20	.05	.05								
	3												
	10	.05	.55	.02	.10								
	15	.00	.00	.00	.00								
	17												
	25												
June/78	31												
	8												
	13												
	19												
	28												
July/78	8												
	10												
	11												

^a Color comparator values

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TABLE 4 (Continued)

Date Mon.	Day	Unit #1			Unit #2			Unit #3		
		Condensor		Plant	Condensor		Plant	Condensor		Plant
		Discharge	Free	Total	Discharge	Free	Total	Discharge	Free	Total
July/78	22				.1			.10		.05
	24				.16			.18		.05
	26									.01
Aug/78	5				.07			.05		.00
	7									.00
	15									.01
	16									
	31	.00	.20	.06	.06					
Sept/78	7									
	11	.00	.11	.01	.01					
	22	.03	.38	.02	.02					
	28	.00	.26	.01	.01					
Oct/78	5	.15	.15	.08	.08					
	7	.11	.26	.05	.05					
	14	.5	.5	.19	.19					
	27									
	30	.35	.35	.10	.10					
Nov/78	1									
	3									
	8	.35	.45	.08	.08					
	11									
	15									
	20									
	22									
	25									
	28	.13	.33	.01	.01					

TABLE 4 (Continued)

Date Mon.	Day	Unit #1			Unit #2			Unit #3		
		Condensor Discharge Free	Plant Total Free	Condensor Discharge Free	Plant Total Free	Condensor Discharge Free	Plant Total Free	Condensor Discharge Free	Plant Total Free	
		Condensor Discharge Total	Plant Total	Condensor Discharge Total	Plant Total	Condensor Discharge Total	Plant Total	Condensor Discharge Total	Plant Total	
Dec/78										
Jan. 79										
Feb/79										
Mar./79	9	1.1	1.1			.05	.05	.01	.01	
	22									
	23									
Apr/79	5	1.12	1.12	.03	.03	.96	.98	.01	.01	
	23	1.0	1.21	.08	.08	1.18	1.52	.20	.20	
	29	.25	.55							

TABLE 5
OHIO RIVER ELEVATION (FT ABOVE MEAN SEA LEVEL)
KAMMER PLANT

<u>Date:</u>	MARCH 1978					APRIL 1978			
	13	20	27	3	10	17	24		
<u>Time</u>									
0800		623	624	624	624	624	623	623	623
1200		623	624	624	624	624	623	623	623
1600		623	624	624	624	624	623	623	623
2000		623	624	625	624	624	623	623	623
2400		623	624	625	624	624	623	623	623
0400		624	624	625	624	624	623	623	623
0800		624	624	625	624	624	623	623	623
MAY 1978									
	1	8	15	22	29	5	12	19	26
0800	623	623	624	624	623	623	623	623	623
1200	623	623	624	624	623	623	623	623	623
1600	623	623	624	624	623	623	623	623	623
2000	623	623	624	624	623	623	623	623	623
2400	623	623	624	624	623	623	623	623	624
0400	623	623	624	624	623	623	623	623	624
0800	623	623	624	624	623	623	623	623	624
1200	623	623	624	624	623	623	623	623	623
JULY 1978									
	3	10	17	24	31	7	14	21	28
0800	623	623	623	623	623	623	623	623	623
1200	623	623	623	623	623	623	623	623	623
1600	623	623	623	623	623	623	623	623	623
2000	623	623	623	623	624	623	623	623	623
2400	623	623	623	624	623	623	623	623	623
0400	623	623	623	624	623	623	623	623	623
0800	623	623	623	623	623	623	623	623	623
1200	623	623	623	623	623	623	623	623	623
AUGUST 1978									
	3	10	17	24	31	7	14	21	28
0800	623	623	623	623	623	623	623	623	623
1200	623	623	623	623	623	623	623	623	623
1600	623	623	623	623	623	623	623	623	623
2000	623	623	623	623	624	623	623	623	623
2400	623	623	623	624	623	623	623	623	623
0400	623	623	623	624	623	623	623	623	623
0800	623	623	623	623	623	623	623	623	623
1200	623	623	623	623	623	623	623	623	623

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TABLE 5 (Continued)

<u>Time</u>	<u>Date:</u>	SEPTEMBER 1978				OCTOBER 1978			
		<u>4</u>	<u>11</u>	<u>18</u>	<u>25</u>	<u>2</u>	<u>9</u>	<u>16</u>	<u>23</u>
0800		623	623	623	623	623	623	623	626
1200		623	623	623	623	623	623	623	626
1600		623	623	623	625	623	623	623	623
2000		623	623	623	625	623	623	623	623
2400		623	623	623	625	623	623	623	623
0400		623	623	623	625	623	623	623	623
0800		623	623	623	623	623	623	623	623
1200		623	623	623	623	623	623	623	623
NOVEMBER 1978									
		<u>6</u>		<u>20</u>		<u>4</u>		<u>18</u>	
0800		623		623		624		623	
1200		623		623		624		623	
1600		623		623		624		623	
2000		623		623		624		623	
2400		623		623		624		623	
0400		623		623		624		623	
0800		623		623		624		623	
1200		623		623		624		623	
JANUARY 1979									
		<u>8</u>		<u>22</u>		<u>5</u>		<u>19</u>	
0800		624		624		623		623	
1200		624		624		623		623	
1600		624		624		623		623	
2000		624		625		623		623	
2400		624		625		623		623	
0400		624		625		623		623	
0800		624		624		623		623	
1200		624		624		623		623	

TABLE 5 (Continued)

<u>Time</u>	<u>Date:</u>	MARCH 1979				APRIL 1979				
		<u>5</u>	<u>12</u>	<u>19</u>	<u>26</u>	<u>2</u>	<u>9</u>	<u>16</u>	<u>23</u>	<u>30</u>
0800		627		623	623	624	624	624	623	623
1200		623		623	623	624	624	624	623	623
1600		627		623	623	624	624	624	623	623
2000		629		623	623	624	624	624	623	623
2400		629		623	623	624	624	624	624	624
0400		629		623	623	624	624	624	624	623
0800		630		623	623	624	625	624	623	623
1200				623	623	625	625	624	623	623

TABLE 6
KAMMER PLANT UNIT OUTAGES

Week in Month Months	Unit #1					Unit #2					Unit #3				
	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
Mar. 1978						X	X				X	X		X	X
April 1978						+		+			X	X	X	X	X
May 1978					+						X				
June 1978	X	X	X												
July 1978	X	X	X	X	X			+							
Aug. 1978	X	X									X	X	X		
Sept. 1978											X	X	X		X
Oct. 1978									+						
Nov. 1978											X				
Dec. 1978												+			
Jan. 1979												X			
Feb. 1979															
Mar. 1979															
April 1979					+										
															X

X - Unit out of service for the entire testing period.
+ - Unit out of service for part of the testing period.

APPENDIX C
KAMMER PLANT
ENTRAINMENT DATA

<u>Table</u>	<u>Title</u>
1	ICHTHYOPLANKTON ENTRAINMENT DATA, KAMMER PLANT, MARCH 1978
2	ICHTHYOPLANKTON ENTRAINMENT DATA, KAMMER PLANT, APRIL 1978
3	ICHTHYOPLANKTON ENTRAINMENT DATA, KAMMER PLANT, MAY 1978
4	ICHTHYOPLANKTON ENTRAINMENT DATA, KAMMER PLANT, JUNE 1978
5	ICHTHYOPLANKTON ENTRAINMENT DATA, KAMMER PLANT, JULY 1978
6	ICHTHYOPLANKTON ENTRAINMENT DATA, KAMMER PLANT, AUGUST 1978

TABLE 1
ICHTHYOPLANKTON ENTRAINMENT DATA^a
KAMMER PLANT
MARCH 1978

DATE:	March 13 & 14	<u>Unit 1-N</u>		<u>Unit 2-N</u>	
		Volume filtered (m ³)	Egg density (#/100m ³)	Larval density (#/100m ³)	
		120.7	0.0	0.0	132.5
		0.0	0.0	0.0	0.0
		0.0			
DATE:	March 20 & 21	<u>Unit 1-N</u>	<u>Unit 2-N</u>		
		104.3	0.0	0.0	105.5
		0.0	0.0	0.0	0.0
		0.0			
DATE:	March 27 & 28	<u>Unit 1-N</u>	<u>Unit 2-N</u>		
		134.5	0.0	0.0	126.9
		0.0	0.0	0.0	0.0
		0.0			

^aSamples were collected at each unit if at least one circulating water pump (CWP) was operating. Units with no data indicate that the unit was out of service and the CWPs were not running. An out of service unit was sampled if a CWP was running.

^bSample represents less than 24 hr.

TABLE 2

ICHTHYOPLANKTON ENTRAINMENT DATA

KAMMER PLANT
APRIL 1978

DATE:	April 3 & 4		
	<u>Unit 1-N</u>		<u>Unit 2-N</u>
Volume filtered (m ³)	137.1		109.2
Egg density (#/100m ³)	0.0		0.0
Larval density (#/100m ³)	0.0		0.0
DATE:	April 10 & 11		
	<u>Unit 1-N</u>		<u>Unit 1-N</u>
Volume filtered (m ³)	124.3		150.2
Egg density (#/100m ³)	0.0		0.0
Larval density (#/100m ³)	0.0		0.0
DATE:	April 17 & 18		
	<u>Unit 1-N</u>		<u>Unit 2-N</u>
Volume filtered (m ³)	131.3		150.0
Egg density (#/100m ³)	0.0		0.0
Larval density (#/100m ³)	0.0		0.0
DATE:	April 24 & 25		
	<u>Unit 1-N</u>		<u>Unit 2-N</u>
Volume filtered (m ³)	160.2		167.2
Egg density (#/100m ³)	0.0		0.0
Larval density (#/100m ³)	0.0		0.0

TABLE 3

ICHTHYOPLANKTON ENTRAINMENT DATA KAMMER PLANT

May 1978

	<u>DATE:</u> May 1 & 2	<u>Unit 1-N</u>	<u>Unit 2-N</u>	<u>Unit 3-N</u>
Volume filtered (m ³)	146.9	152.9	117.8	
Egg density (#/100m ³)	0.0	0.0	0.0	
Larval density (#/100m ³)	0.0	0.0	0.0	
	<u>DATE:</u> May 8 & 9	<u>Unit 1-N</u>	<u>Unit 2-N</u>	<u>Unit 3-N</u>
Volume filtered (m ³)	147.8	143.6	175.9	
Egg density (#/100m ³)	0.0	0.7	26.2	
Larval density (#/100m ³)	0.7	0.7	2.8	
<u><i>Stizostedion</i> sp.</u>	0	0	2	
Number	0	0	1.1	
Density (#/100m ³)	0.0	0.0	40.0	
% composition	0.0	0.0		
<u>Unidentifiable</u>				
Number	1	1	3	
Density (#/100m ³)	0.7	0.7	1.7	
% composition	100.0	100.0	60.0	
	<u>DATE:</u> May 15 & 16	<u>Unit 1-N</u>	<u>Unit 2-N</u>	<u>Unit 3-N</u>
Volume filtered (m ³)	150.6	138.9	136.6	
Egg density (#/100m ³)	0.7	0.0	0.0	
Larval density (#/100m ³)	0.7	0.7	0.0	

TABLE 3 (Continued)

DATE:	May 15 & 16 (Cont'd)	<u>Unit 1-N</u>	<u>Unit 2-N</u>	<u>Unit 3-N</u>
Unidentified sucker				
Number	1	0	0	0
Density (#/100m ³)	0.7	0.0	0.0	0.0
% composition	100.0	0.0	0.0	0.0
<i>Stizostedion</i> sp.				
Number	0	0	0	0
Density (#/100m ³)	0.0	0.7	0.0	0.0
% composition	0.0	100.0	0.0	0.0
DATE:	May 22 & 23	<u>Unit 1-N</u>	<u>Unit 2-N</u>	<u>Unit 3-N</u>
Volume filtered (m ³)	99.0	110.5	108.7	
Egg density (#/100m ³)	0.0	0.0	0.0	
Larval density (#/100m ³)	0.0	0.0	0.0	
DATE:	May 29 & 30	<u>Unit 1-N^b</u>	<u>Unit 2-N</u>	<u>Unit 3-N</u>
Volume filtered (m ³)	20.5	152.7	126.4	
Egg density (#/100m ³)	0.0	0.0	0.0	
Larval density (#/100m ³)	0.0	0.6	0.0	
Carp				
Number	0	1	0	
Density (#/100m ³)	0.0	0.6	0.0	
% composition	0.0	100.0	0.0	

TABLE 4

ICHTHYOPLANKTON ENTRAINMENT DATA
KAMMER PLANT

JUNE 1978

DATE:	JUNE 5 & 6	Unit 1-N	Unit 2-N	Unit 3-N
Volume filtered (m ³)	154.2	131.8	132.1	
Egg density (#/100m ³)	0.0	0.0	2.3	
Larval density (#/100m ³)	40.9	27.4	40.9	
Unidentified cyprinid				
Number	9	8	18	
Density (#/100m ³)	5.8	6.1	13.6	
% composition	14.3	22.2	33.3	
Unidentified percid				
Number	1	0	0	
Density (#/100m ³)	0.6	0.0	0.0	
% composition	1.6	0.0	0.0	
Carp				
Number	36	9	27	
Density (#/100m ³)	23.3	6.8	20.4	
% composition	57.1	25.0	50.0	
Unidentified sucker				
Number	0	3	0	
Density (#/100m ³)	0.0	2.3	0.0	
% composition	0.0	8.3	0.0	
<u>Stizostedion sp.</u>				
Number	0	1	0	
Density (#/100m ³)	0.0	0.8	0.0	
% composition	0.0	2.8	0.0	

TABLE 4 (Continued)

DATE:	June 5 & 6 (Cont'd)	<u>Unit 1-N</u>	<u>Unit 2-N</u>	<u>Unit 3-N</u>
Unidentifiable				
Number	17	15	9	
Density (#/100m ³)	11.0	11.4	6.8	
% composition	27.0	41.7	16.7	
DATE:	June 12 & 13	<u>Unit 2-N</u>	<u>Unit 3-N</u>	
Volume filtered (m ³)	114.1	112.5		
Egg density (#/100m ³)	0.0	0.0		
Larval density (#/100m ³)	78.0	100.4		
Unidentified cyprinid				
Number	33	58		
Density (#/100m ³)	28.9	51.6		
% composition	37.1	51.3		
Carp				
Number	8	11		
Density (#/100m ³)	7.0	9.8		
% composition	9.0	9.7		
Unidentified herring				
Number	1	1		
Density (#/100m ³)	0.9	0.8		
% composition	1.1	0.9		
Unidentified percid				
Number	3	0		
Density (#/100m ³)	2.6	0.0		
% composition	3.4	0.0		

TABLE 4 (Continued)

DATE:	June 12 & 13 (Cont'd)	Unit 2-N	Unit 3-N
Unidentifiable			
Number	44	43	
Density (#/100m ³)	38.6	38.2	
% composition	49.4	38.1	
 DATE: June 19 & 20			
		Unit 2-N	Unit 3-N
Volume filtered (m ³)	111.7	118.7	
Egg density (#/100m ³)	0.0	0.0	
Larval density (#/100m ³)	115.5	159.2	
 Carp			
Number	1	0	
Density (#/100m ³)	0.9	0.0	
% composition	0.8	0.0	
 Unidentified cyprinid			
Number	38	141	
Density (#/100m ³)	34.0	118.8	
% composition	29.5	74.6	
 White bass			
Number	0	1	
Density (#/100m ³)	0.0	0.8	
% composition	0.0	0.5	
 Unidentified catfish			
Number	0	1	
Density (#/100m ³)	0.0	0.8	
% composition	0.0	0.5	

TABLE 4 (Continued)

DATE:	June 19 & 20 (cont'd)	<u>Unit 2-N</u>	<u>Unit 3-N</u>
Unidentifiable			
Number	90	46	
Density (#/100m ³)	80.6	38.8	
% composition	69.8	34.3	
DATE:	June 26 & 27	<u>Unit 2-N</u>	<u>Unit 3-N</u>
Volume filtered (m ³)	188.5	181.1	
Egg density (#/100m ³)	0.0	0.0	
Larval density (#/100m ³)	50.9	129.2	
Carp			
Number	4	10	
Density (#/100m ³)	2.1	5.5	
% composition	4.2	4.3	
Unidentified percid			
Number	1	0	
Density (#/100m ³)	0.5	0.0	
% composition	1.0	0.0	
Unidentified cyprinid			
Number	25	33	
Density (#/100m ³)	13.3	18.2	
% composition	26.0	14.1	
White bass			
Number	0	1	
Density (#/100m ³)	0.0	0.6	
% composition	0.0	0.4	

TABLE 4 (Continued)

		<u>Unit 2-N</u>	<u>Unit 3-N</u>
DATE:	June 26 & 27		
Unidentified catfish			
Number		0	1
Density (#/100m ³)		0.0	0.6
% composition		0.0	0.4
Yellow perch			
Number		0	2
Density (#/100m ³)		0.0	1.1
% composition		0.0	0.8
Unidentifiable			
Number		66	187
Density (#/100m ³)		35.0	103.2
% composition		68.8	79.9

TABLE 5

ICHTHYOPLANKTON ENTRAINMENT DATA
 KAMMER PLANT
 JULY 1978

DATE: July 3 & 4

	<u>Unit 3-N</u>		
Volume filtered (m^3)	178.7	0.6	0.1
Egg density (#/100m 3)	0.0		
Larval density (#/100m 3)	598.8		
Yellow perch	4	2.2	0.4
Number			
Density (#/100m 3)			
% composition			
Carp	1	0.6	0.1
Number			
Density (#/100m 3)			
% composition			
Unidentified minnow	879	491.9	82.1
Number			
Density (#/100m 3)			
% composition			
Unidentified herring	2	1.1	0.2
Number			
Density (#/100m 3)			
% composition			
Unidentifiable	184	103.0	17.2
Number			
Density (#/100m 3)			
% composition			

TABLE 5 (Continued)

		<u>Unit 2-N</u>	<u>b</u>	<u>Unit 3-N</u>
DATE:	July 17 & 18			
Volume filtered	(m ³)	23.3		25.0
Egg density (#/100m ³)		0.0		0.0
Larval density (#/100m ³)		85.8		20.0
Unidentifiable				
Number		20		5
Density (#/100m ³)		85.8		20.0
% composition		100.0		100.0
DATE:	July 24 & 25			
Volume filtered	(m ³)	104.4		
Egg density (#/100m ³)		0.0		
Larval density (#/100m ³)		123.5		
Unidentified cyprinid				
Number		25		
Density (#/100m ³)		23.9		
% composition		19.4		
Unidentifiable				
Number		104		
Density (#/100m ³)		99.6		
% composition		80.6		
DATE:	July 31 & August 1			
Volume filtered	(m ³)	101.1		94.5
Egg density (#/100m ³)		0.0		0.0
Larval density (#/100m ³)		97.9		76.2

TABLE 5 (Continued)

		<u>DATE: July 31 & August 1</u>	<u>(Cont'd) Unit 2-N</u>	<u>Unit 3-N</u>
Unidentified cyprinid				
Number		67	39	
Density (#/100m ³)		66.3	41.3	
% composition		67.7	54.2	
Unidentifiable				
Number		32	33	
Density (#/100m ³)		31.7	34.9	
% composition		32.3	45.8	

TABLE 6

ICHTHYOPLANKTON ENTRAINMENT DATA
 KAMMER PLANT
 AUGUST 1978

DATE:	August 7 & 8	<u>Unit 2-N</u>			<u>Unit 3-N</u>		
		Volume filtered (m^3)	Egg density (#/ $100m^3$)	Larval density (#/ $100m^3$)	Number	Density (#/ $100m^3$)	% composition
Unidentified cyprinid		4	3.8	19.0	10	9.5	37.0
Unidentified herring		0	0.0	0.0	1	1.0	3.7
Unidentifiable		17	16.2	81.0	16	15.2	59.3
DATE: August 14 & 15		<u>Unit 2-N^b</u>			<u>Unit 3-N</u>		
Unidentified cyprinid		2	1.6	33.3	1	0.7	50.0

TABLE 6 (Continued)

		<u>Unit 2-N</u>	<u>Unit 3-N</u>
DATE:	August 14 & 15 (Cont'd)		
Unidentifiable			
Number		4	1
Density (#/100m ³)		3.2	0.7
% composition		66.7	50.0
DATE:	August 21 & 22		
Unidentifiable			
Volume filtered (m ³)		80.1	113.8
Egg density (#/100m ³)		0.0	0.0
Larval density (#/100m ³)		0.0	7.1
Unidentified minnow			
Number		0	7
Density (#/100m ³)		0.0	6.2
% composition		0.0	87.5
Unidentified herring			
Number		0	1
Density (#/100m ³)		0.0	0.9
% composition		0.0	12.5
DATE:	August 28 & 29		
Unidentifiable			
Volume filtered (m ³)		101.4	
Egg density (#/100m ³)		0.0	
Larval density (#/100m ³)		29.6	
Unidentified herring			
Number		26	
Density (#/100m ³)		25.6	
% composition		86.7	

TABLE 6 (Continued)

DATE:	August 28 & 29 (Cont.)		
<u>Unit 1-N</u>			
Unidentified cyprinid			
Number	3		
Density (#/100m ³)	2.9		
% composition	10.0		
Unidentifiable			
Number	1		
Density (#/100m ³)	1.0		
% composition	3.3		

APPENDIX D

KAMMER PLANT INTAKE

WATER VELOCITY STUDIES

INTRODUCTION

In conjunction with the Kammer Plant impingement and entrainment studies, intake water velocity (speed only) measurements were to have been made in front of the traveling screens once per month. During the first six months of the study, minor problems continually occurred which hindered collection of accurate and complete velocity data. Debris within the intake bays, poor operating condition of trash rakes and associated equipment and availability and scheduling of screen operators were some of the problems. Because these problems were expected to continue, discussions were held with appropriate AEP project personnel in an attempt to resolve them. As a result of these discussions, it was decided to discontinue taking velocity measurements inside the intake structure and to perform a one time study in the river out in front of the intake structure. The one time study would be performed to collect data on current speed and direction, bathymetry and, in general terms, describe the bottom sediment composition. In addition, velocity readings would be made inside each intake, if conditions permitted. The Kammer Plant river velocity study was performed on July 11, 1979.

METHODS

River Current Speed and Direction

Current speed and direction measurements were made with a Hydro-Products Model 451 Current Speed Readout Module and Model 460 Underwater Sensor (Figure 1). This is a precision balanced high impact polystyrene Savonious rotor system. The rotor rotates at a rate of 83.5 revolutions per knot with an accuracy of $\pm 3\%$.

The sensor, within its protective cage, was adapted so that the unit could slide up and down a cable used to maintain vertical positioning in the water column. A 170 lb weight was attached to the cable and lowered to the bottom to maintain a vertical position.

Direction measurements were made with a Hydro-Products Model 465A Direction Sensor. This sensor, within its protective cage, was attached to the speed sensor as shown in Figure 1. Current direction was measured in degrees relative to magnetic north.

Three transects were established in the river out in front of the Kammer Plant intake. One transect was established along the face of the intake structure and the others 20 and

67 m away from and parallel to the intake structure. Velocity (ft/sec) and direction (degrees) readings were taken along each transect at the surface and 1 m intervals to the bottom.

Bathometry

Depth measurements were taken using a sounding line (measuring tape attached to a weight) or a Heath-Kit Fish Spotter and Depth Finder Model MI-29. Measurements were taken along the three transects established for measuring current speed and direction and at other selected points to adequately describe the bottom contour.

Sediments

Bottom sediment samples were collected at selected locations using a Ponar grab sampler. In the field, substrate types were noted e.g., gravel, sand, clay, etc. Each sample was then placed in a container and returned to the laboratory for further analysis.

In the laboratory, particle size estimates were made using a modified sieve procedure. Water was added to the sediment samples and vigorously agitated. A 500 ml aliquot was taken and processed through a series of U.S.A. Standard Testing

Sieves. A visual estimate of the substrate retained in each sieve was then made and the results reported as percent composition.

In-Plant Current Speed

Velocity measurements within the intake structure were made concurrent with the river measurements. A Marsh McBirney Model 201 Flow Meter was used. This is a electromagnetic meter with an accuracy of $\pm 2\%$. The sensor was lowered into an intake bay using a manual support device which slides down the trash rake guides or it was attached to the plant trash rakes which were lowered through the water column.

The manual support was lowered through the water column with the velocity sensor fixed in a particular position, for example, facing the river, to measure the currents coming into the plant or facing the traveling screens, to determine if there were currents away from the screens. The sensor could be positioned across the manual support so that readings could be obtained at any position across the width of the bay (traveling screen).

The plant trash rakes were also used as a place of attachment for the velocity sensor. Use of trash rakes required the assistance of plant personnel. During the initial stages of the impingement/entrainment studies, the sensor was allowed to move freely while seeking the true current direction. The disadvantage to this procedure was that current direction was not known. Later, the sensor was fixed facing the river or the traveling screens to measure the magnitude of that component.

RESULTS

River Current Speed and Direction

The results of the current speed and direction survey are graphically shown in Figures 2 through 10 and are also tabulated in Table 1. If no velocity readings are shown in the figures and table, it can be assumed that bottom was reached.

Bathymetry

Bottom contour lines in front of the Kammer Plant intake are shown in Figure 11.

Sediments

The results of field observations and laboratory analyses of the grab samples taken at the Kammer Plant are presented in Table 2 and shown in Figure 12.

In-Plant Current Speed

All in-plant data collected during the impingement/entrainment surveys and during the one time current speed and direction survey are presented in Table 3.

TABLE 1

VELOCITY (ft/sec) AND DIRECTION (DEGREES) READINGS TAKEN ALONG THE FACE OF THE KAMMER INTAKE STRUCTURE AND ALONG TRANSECTS ESTABLISHED AT 20 AND 67 METERS OUT FROM THE FACE.
 READINGS WERE TAKEN AT POINTS CORRESPONDING TO THE MIDDLE BAY OF EACH
 UNIT AND AT ONE METER INTERVALS TO THE BOTTOM

Unit: Depth	Face of Intake Structure					
	1		2			
	ft/sec	degrees	ft/sec	degrees	ft/sec	degrees
Surface	0.23	142	0.30	100	0.35	130
1 meter	0.30	140	0.33	138	0.30	134
2 meter	0.27	155	0.37	118	0.37	122
3 meter	0.27	145	0.34	120	0.51	120
4 meter	0.39	155	0.37	165	0.51	115
5 meter	0.44	154	0.46	132	0.51	100
6 meter	0.51	55	0.71	140		
7 meter	0.51	150				
8 meter	0.54	150				
			20 Meter Transect			
Surface	0.71	122	0.61	115	0.30	192
1 meter	0.64	138	0.61	115	0.47	95
2 meter	0.62	140	0.40	132		
3 meter	0.59	165	0.59	145		
4 meter	0.54	135				
5 meter	0.68	120				
6 meter	0.66	102				
7 meter	0.68	98				
			67 Meter Transect			
Surface	0.27	138				
1 meter	0.27	205				

TABLE 2

DESCRIPTION OF BOTTOM SEDIMENTS IN FRONT OF THE
 KAMMER PLANT INTAKE STRUCTURE.
 SAMPLES COLLECTED ON JULY 11, 1979

<u>Station</u>	Estimated Percent Composition							<u>Sediment Color</u>	<u>Wentworth Grade Classification</u>
	U.S.A. Standard Sieve Mesh Size #	5	10	18	35	60	120	230	
A2	No Sample Collected (bottom debris)								
A5	No Sample Collected (bottom debris)								
A8	<1	5	5	15	25	25	25	Brown	Medium to Very Fine Sand
B2	25	20	10	10	15	10	10	Light Brown	Pebble to Granule
B5 (a) (b)	<1	5	5	20	30	20	20	Brown	Medium Sand
B8 (a)	5	5	10	20	30	20	10	Brown	Medium Sand
C5 (a)	5	5	5	10	10	30	35	Brown	Very Fine Sand

(a) organic material (leaves) present

(b) oil present

TABLE 3
VELOCITY (fps) READINGS TAKEN AT THE KAMMER PLANT INTAKE
DURING 1978 AND 1979

April 28, 1978						Ohio River El. 623 MSL						
1MCV			1MCV			Depth			Velocity			
Depth	Velocity		Depth	Velocity		Depth	m		Depth	Velocity		
m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	
0.3	0.1	0	-0.3	0.3	0.1	0	-0.2	0.3	0.1	0	-0.3	
3.0	0.5	0	-1.2	3.0	0.1	0	-0.2	3.0	0.1	0	-0.2	
5.8	0.6	0.5-0.7	5.8	1.0	0.9-1.1	5.8	1.3	1.1-1.5	5.8	1.0	0.9-1.0	
May 25, 1978						Ohio River El. 624 MSL						
2MCR			Depth			Velocity			Depth			
Depth	Velocity		Depth	Velocity		Depth	m		Depth	Velocity		
m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	
0.3	0.4	0.3-0.5	0.3	0	BZ	-0.1	0.3	BZ	-	0.3	0.4	0.2-0.5
1.2	1.1	0.6-1.4	1.2	0.1	BZ	-0.2	1.2	BZ	-	1.2	0.6	0.5-0.8
2.1	0.2	0.1-0.2	2.1	0	BZ	-0.1	2.1	BZ	-	2.1	0.5	0.3-0.6
3.0	0.2	0.1-0.2	3.0	BZ	-	3.0	BZ	-	3.0	0.6	0.4-0.7	
4.0	0.7	0.2-0.9	4.0	0.8	0.4-0.9	4.0	BZ	-	4.0	0.5	0.3-0.5	
4.9	0.4	0.1-0.9	4.9	1.9	1.7-2.0	4.9	BZ	-	4.9	0.5	0.4-0.6	
5.8	0.3	0.2-0.4	5.8	2.0	1.8-2.2	5.8	BZ	-	5.8	0.8	0.4-1.2	
June 30, 1978						Ohio River El. 623 MSL						
2MCR			Depth			Velocity			Depth			
Depth	Velocity		Depth	Velocity		Depth	m		Depth	Velocity		
m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	
0.3	0.1	BZ -0.4	0.3	BZ	-	0.3	0.5	0	-1.0			
1.2	0.5	0.3-0.7	1.2	BZ	-	1.2	0.6	0.5-0.7				
2.1	0.4	0.2-0.6	2.1	BZ	-	2.1	0.7	0.5-1.0				
3.0	BZ	-	3.0	0.2	0.2-0.3	2.7	1.1	1.0-1.2				
4.0	0.5	0	-0.8	3.0	BZ	-						
4.9	2.2	1.7-2.3	4.9	BZ	-							
5.5	2.4	2.2-2.5	5.5	BZ	-							

(a) 1SC - First number designates unit
First letter designates unit bay S (south) M (middle) N (north)
Second letter designates location within bay where readings were taken
S (south) M (middle) N (north)

Third letter designates direction sensor was facing to make readings R (river) P (plant)
V (velocity at true current direction)

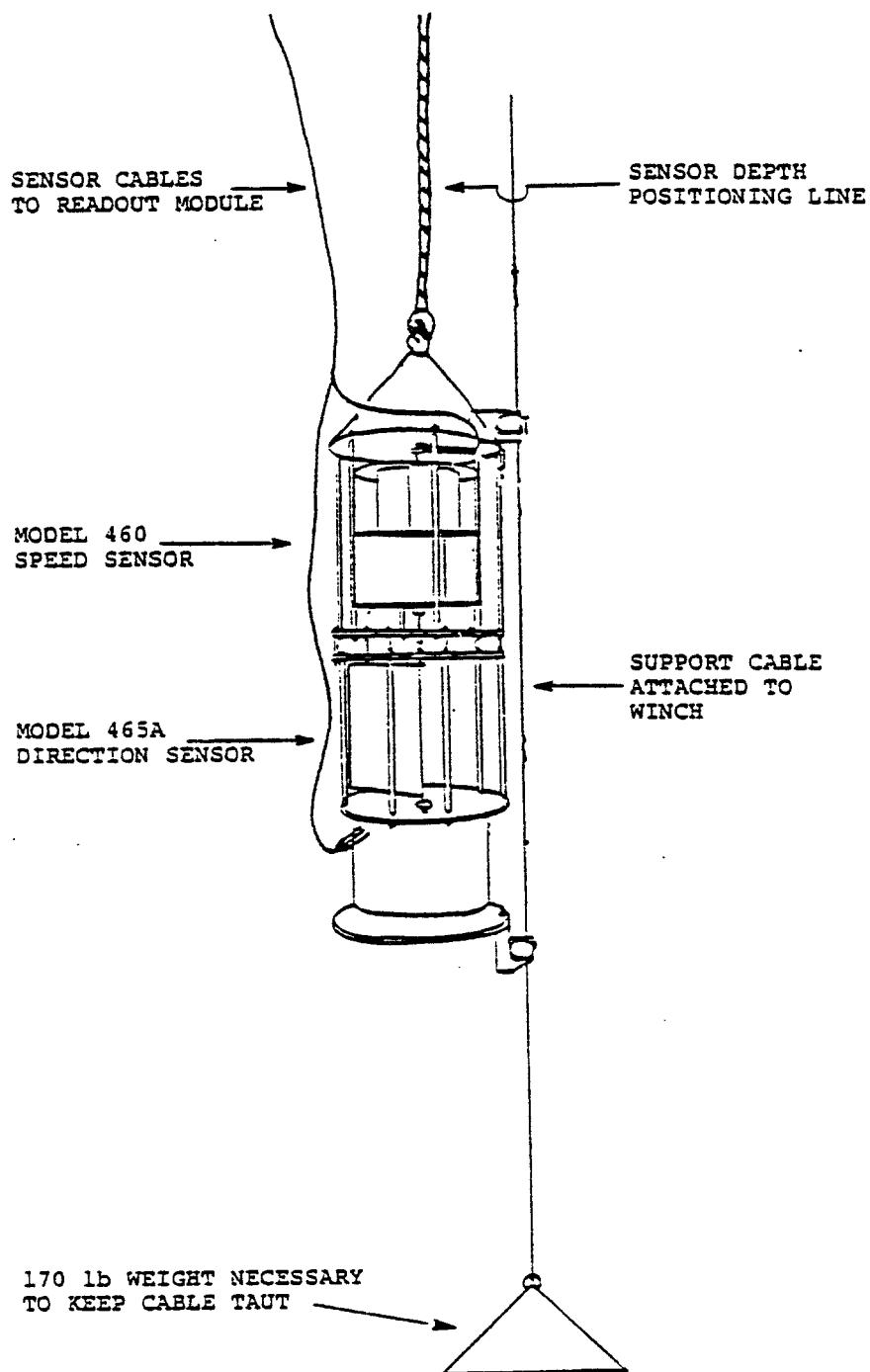
(b) BZ - Below zero reading scale.

TABLE 3 (CONTINUED)

August 1, 1978 Ohio River E1 623 MSL						August 25, 1978 Ohio River E1 623 MSL						July 10, 1979 Ohio River E1 623 MSL						1MCR		
3MCP			3NSR			3NCR			3NCP			3NNR			1MSR			1MCR		
Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	
m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	
0.3	BZ	-	0.3	0.1	0 -0.1	0.3	0	0 -0.1	0.3	0	0 -0.1	0.3	0.1	0 -0.1	0.3	0.4	0 -0.5	1.2	BZ	-0.1
1.2	BZ	-	1.2	0	BZ -0.1	1.2	0	BZ -0.1	1.2	0	BZ -0.1	1.2	0.1	BZ 0	1.2	0.2	0 -0.3	2.1	BZ	-
2.1			2.1	0.1	BZ -0.1	2.1	0.1	BZ -0.1	2.1	0	BZ -0.1	2.1	0.5	BZ -0.7	2.1	0	-0.2			
3.0			3.0	0.1	0 -0.1	3.0	0.1	BZ -0.1	3.0	0	BZ -0.1	3.0	0.1	BZ -0.1	3.0	0.2	0 -0.3	4.0	BZ	-
4.0			4.0	0.1	0 -0.1	4.0	0.1	BZ -0.1	4.0	0	BZ -0.1	4.0	0.2	0.1-0.3	4.0	0.2	0 -0.3	4.9	BZ	-
4.9			4.9	0.1	0 -0.2	4.9	0	BZ -0.1	4.9	0.3	BZ -0.1	4.9	0.2	BZ -0.1	4.9	0.2	0 -0.3	5.8	BZ	-
5.8			5.8	1.8	1.9	5.8	BZ	-	5.8	1.9	1.8-2.0	5.8	BZ	-	5.8	0.9	0 -1.0			
October 24, 1978 Ohio River E1 623 MSL						ISCR						ISNR						1MCR		
Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	
m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	
0.3	0.4	0.3-0.4	0.3	BZ	-	0.3	BZ	-	0.3	BZ	-	0.3	0.2	0.1-0.2	0.3	0.3	BZ	-0		
1.2	0	0 -0.1	1.1	0	0 -0.1	1.2	0.1	0 -0.1	1.2	0.1	0 -0.1	1.2	0.6	0.5-0.6	1.2	1.1	0.7-1.2			
2.1	0.1	0.1-0.2	2.1	0	BZ -0	2.1	0.2	0.1-0.2	2.1	0.2	0.1-0.2	1.5	0.4	0.3-0.4	2.1	0	0 -0.1			
3.0	BZ	-	3.0	BZ	-	3.0	BZ	-	3.0	BZ	-	3.0	BZ	-	3.0	0	BZ	-		
4.0	BZ	-	4.0	BZ	-	4.0	BZ	-	4.0	BZ	-	4.0	0	0 -0.1	4.0	0	0 -0.1			
July 10, 1979 Ohio River E1 623 MSL						2MCR						3MCR						2MCP		
Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	Depth	Velocity	
m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	Range	m	\bar{x}	
0.3	0	BZ -0	0.3	0	BZ -0	0.3	0.1	0 -0.2	0.3	0.1	0 -0.2	0.3	BZ	-	0.3	0.3	0.2-0.4	0.3	0.5	0.2-0.7
1.0	0.5	0.4-0.8	1.0	BZ	-	1.0	0.3	0.2-0.4	1.0	0.3	0.2-0.4	1.0	BZ	-	1.0	5.0	4.9-5.1	1.0	BZ	-
2.0	0.6	0.5-0.7	2.0	BZ	-	2.0	0.5	0.4-0.6	2.0	0.5	0.4-0.6	2.0	BZ	-	2.0	4.9	4.8-5.0	2.0	BZ	-
3.0	BZ -0	3.0	0.3	0.2-0.4	3.0	BZ	-	3.0	0.3	0.2-0.4	3.0	0.8	0.7-0.9	3.0	1.7	1.6-1.9	3.0	BZ	-	
4.0	0	0 -0	3.0	0.1	0.1-0.2	4.0	BZ	-	4.0	0.1	0.1-0.2	4.0	0.6	0.6-0.6						
5.0	1.3	1.2-1.5	5.0	BZ	-															

FIGURE 1

HYDRO PRODUCTS SYSTEM ARRANGEMENT



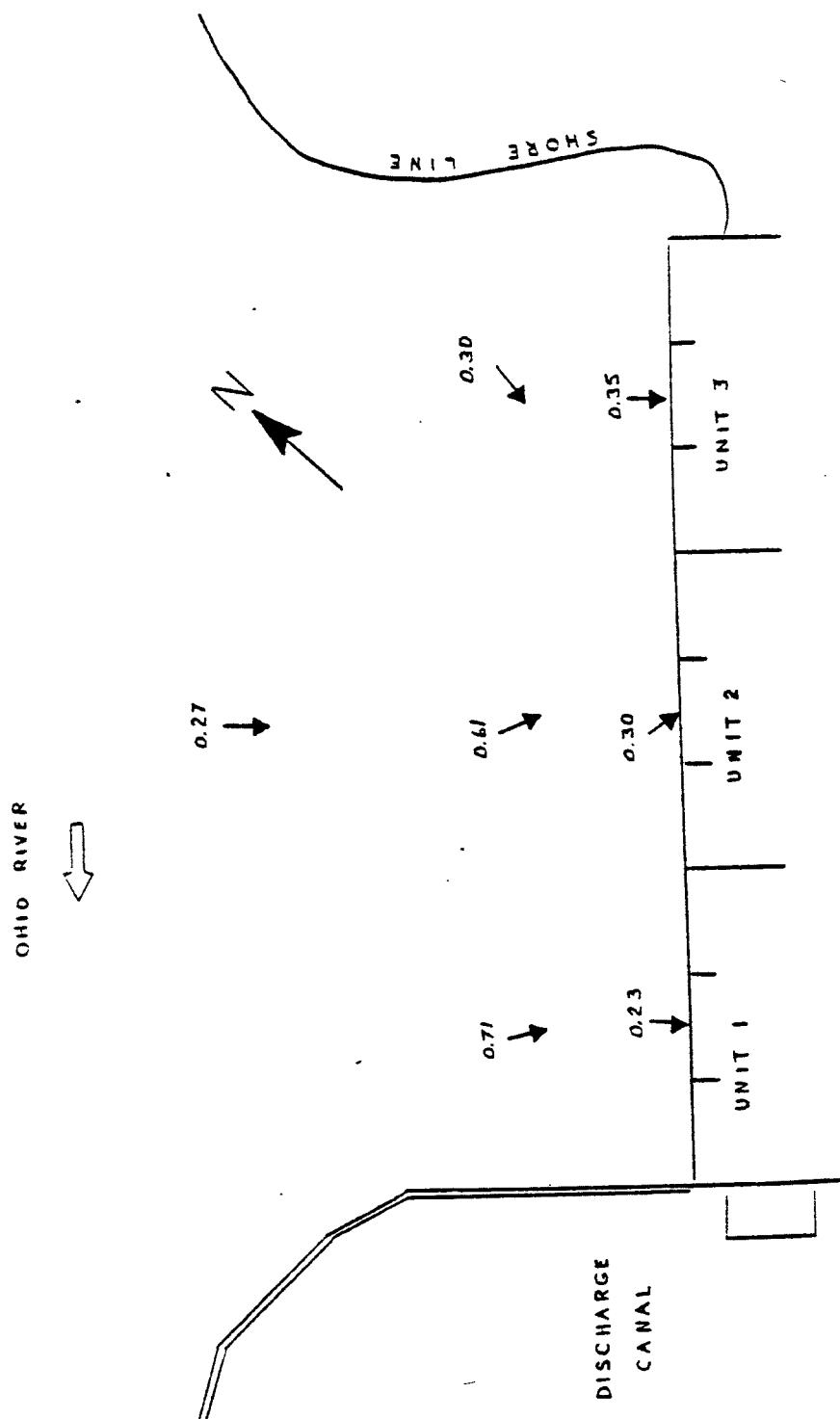


FIGURE 2
VELOCITY (ft/sec) AND DIRECTION OF CURRENTS IN FRONT OF THE
KAMMER PLANT INTAKE STRUCTURE
SURFACE READINGS

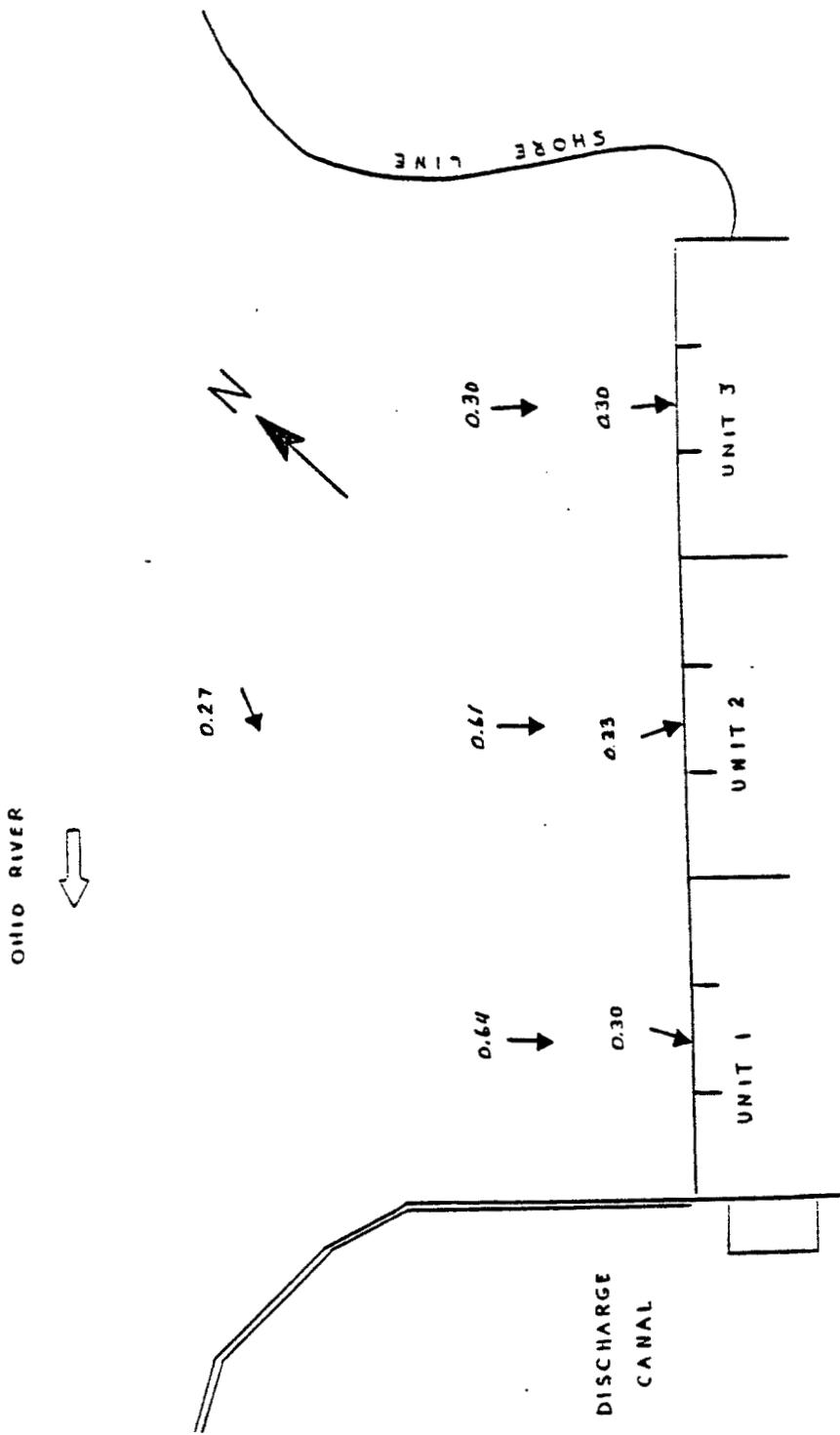


FIGURE 3
VELOCITY (ft/sec) AND DIRECTION OF CURRENTS IN FRONT OF THE
KAMMER PLANT INTAKE STRUCTURE
ONE METER DEPTH READINGS

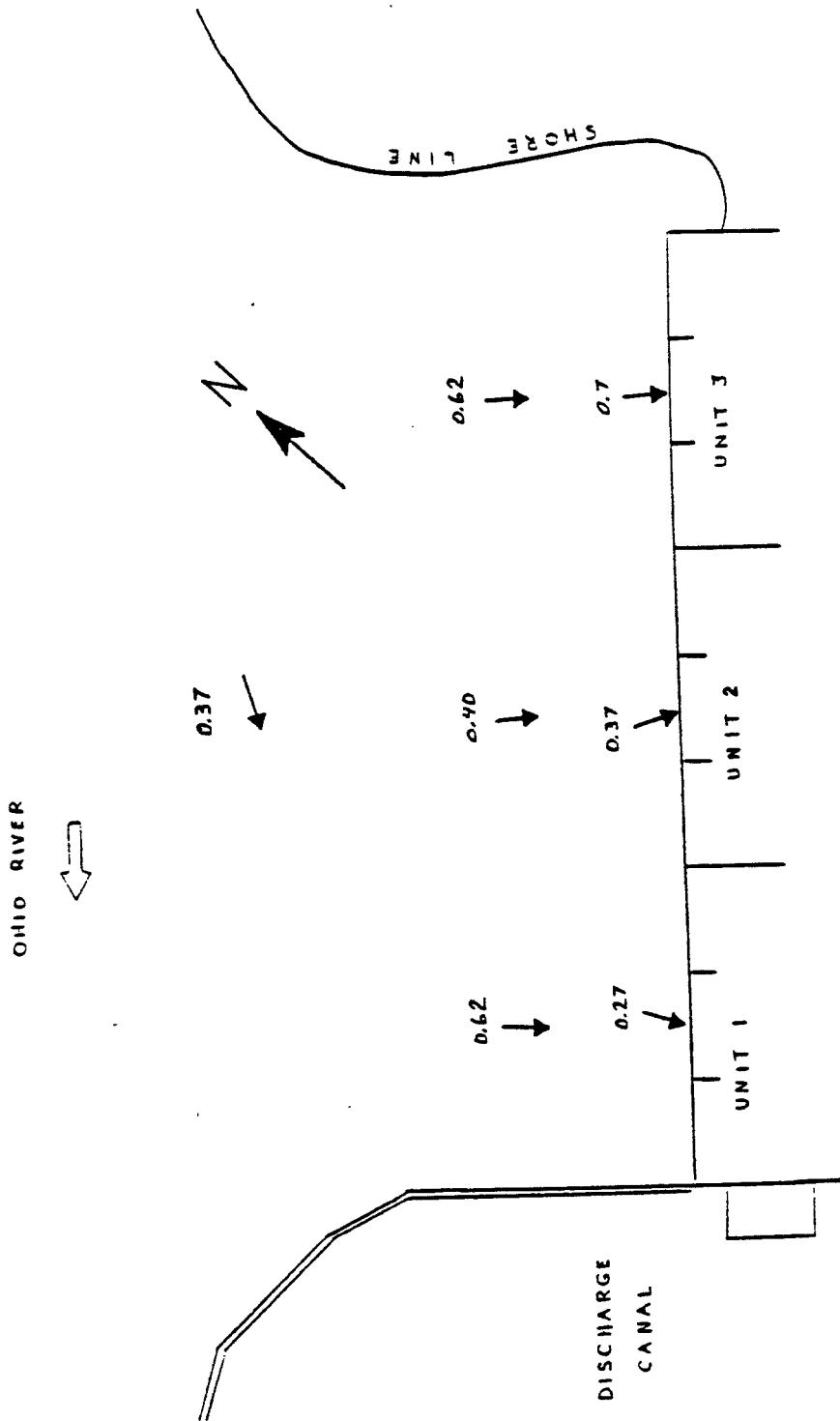


FIGURE 4
VELOCITY (ft/sec) AND DIRECTION OF CURRENTS IN FRONT OF THE
KAMMER PLANT INTAKE STRUCTURE
TWO METER DEPTH READINGS

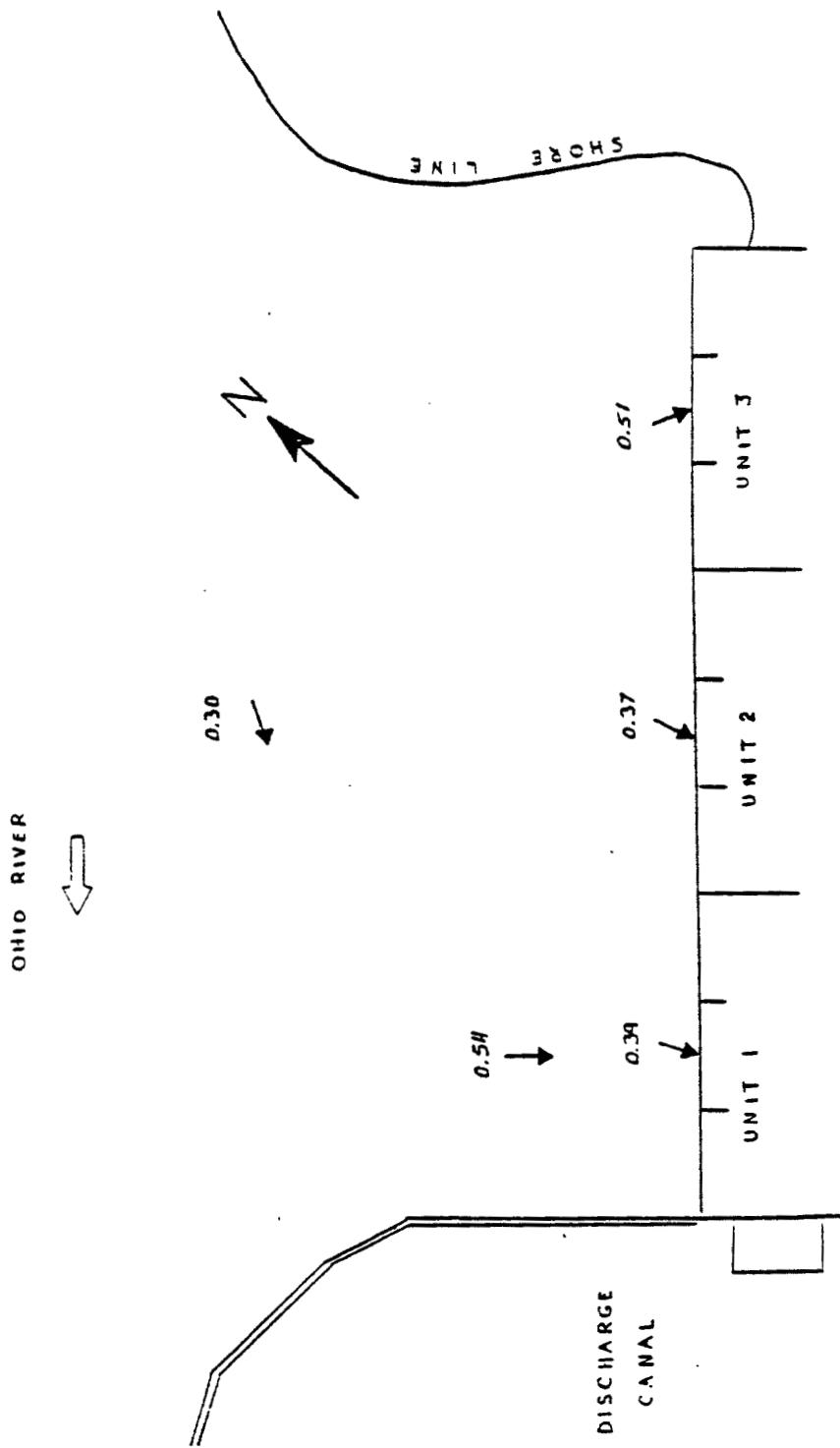


FIGURE 6
VELOCITY (ft/sec) AND DIRECTION OF CURRENTS IN FRONT OF THE
KAMMER PLANT INTAKE STRUCTURE
FOUR METER DEPTH READINGS

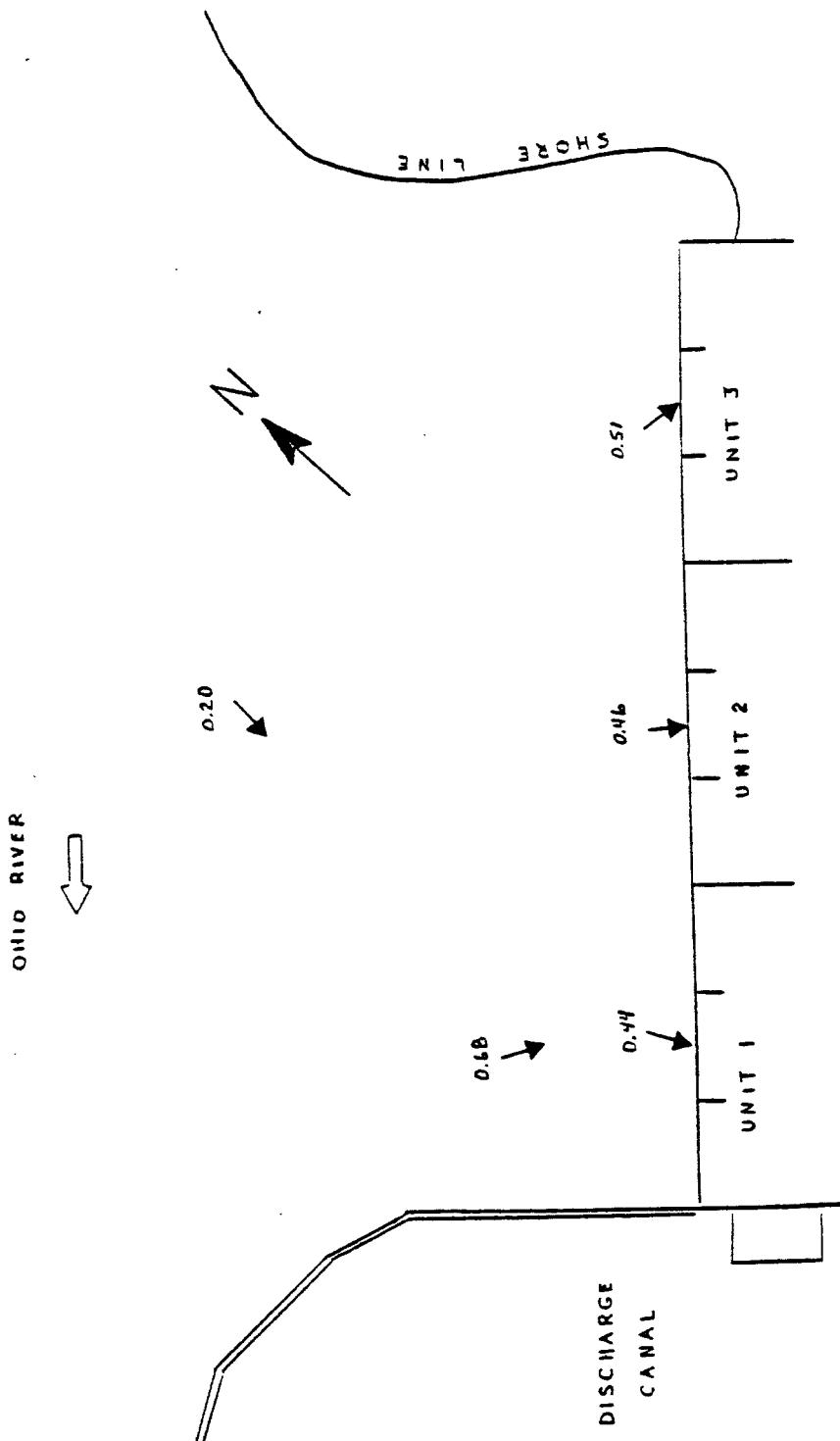


FIGURE 7

VELOCITY (ft/sec) AND DIRECTION OF CURRENTS IN FRONT OF THE
 KAMMER PLANT INTAKE STRUCTURE
 FIVE METER DEPTH READINGS

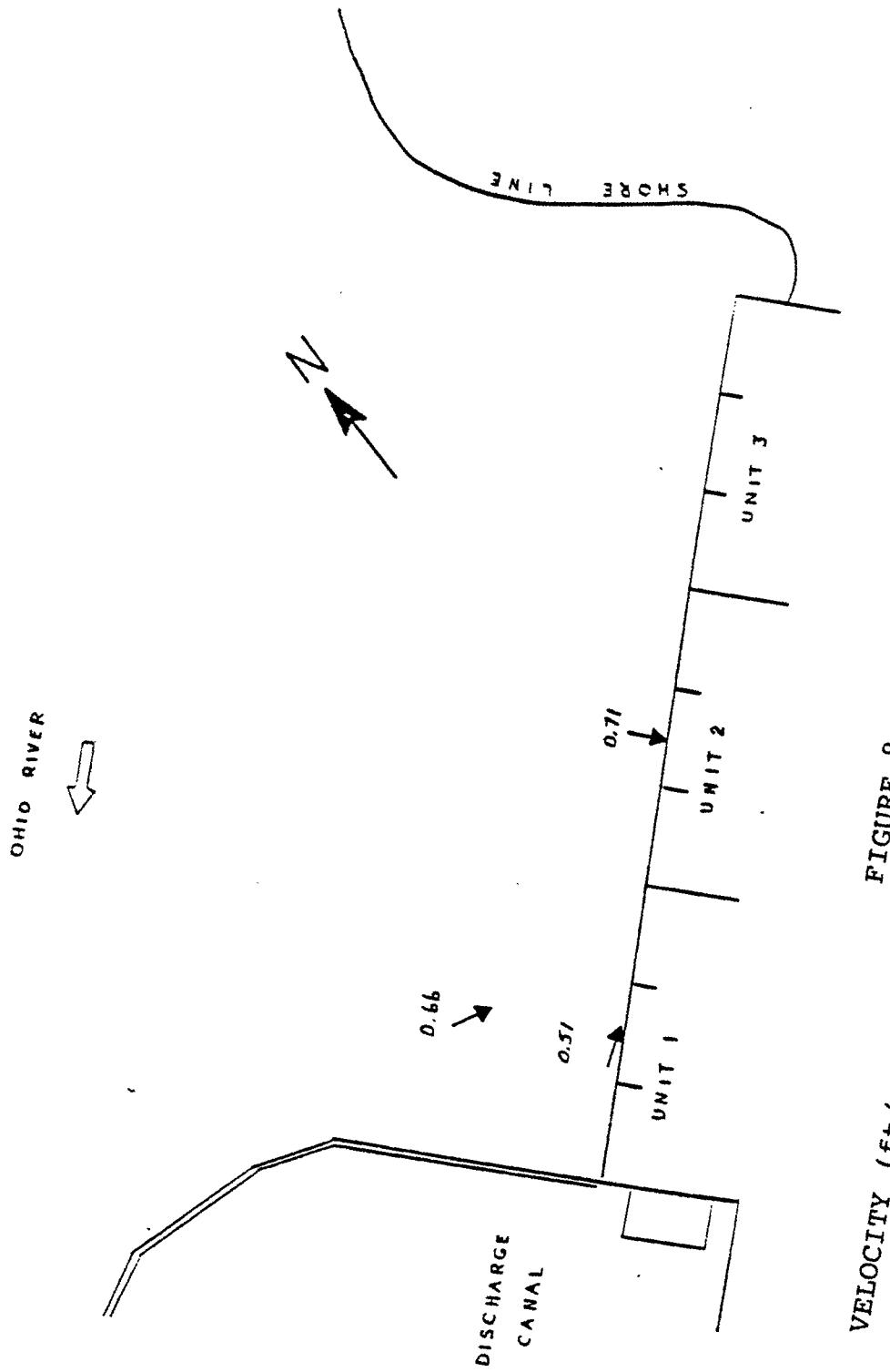


FIGURE 8
KAMMER PLANT INTAKE STRUCTURE IN FRONT OF THE
SIX METER DEPTH READINGS

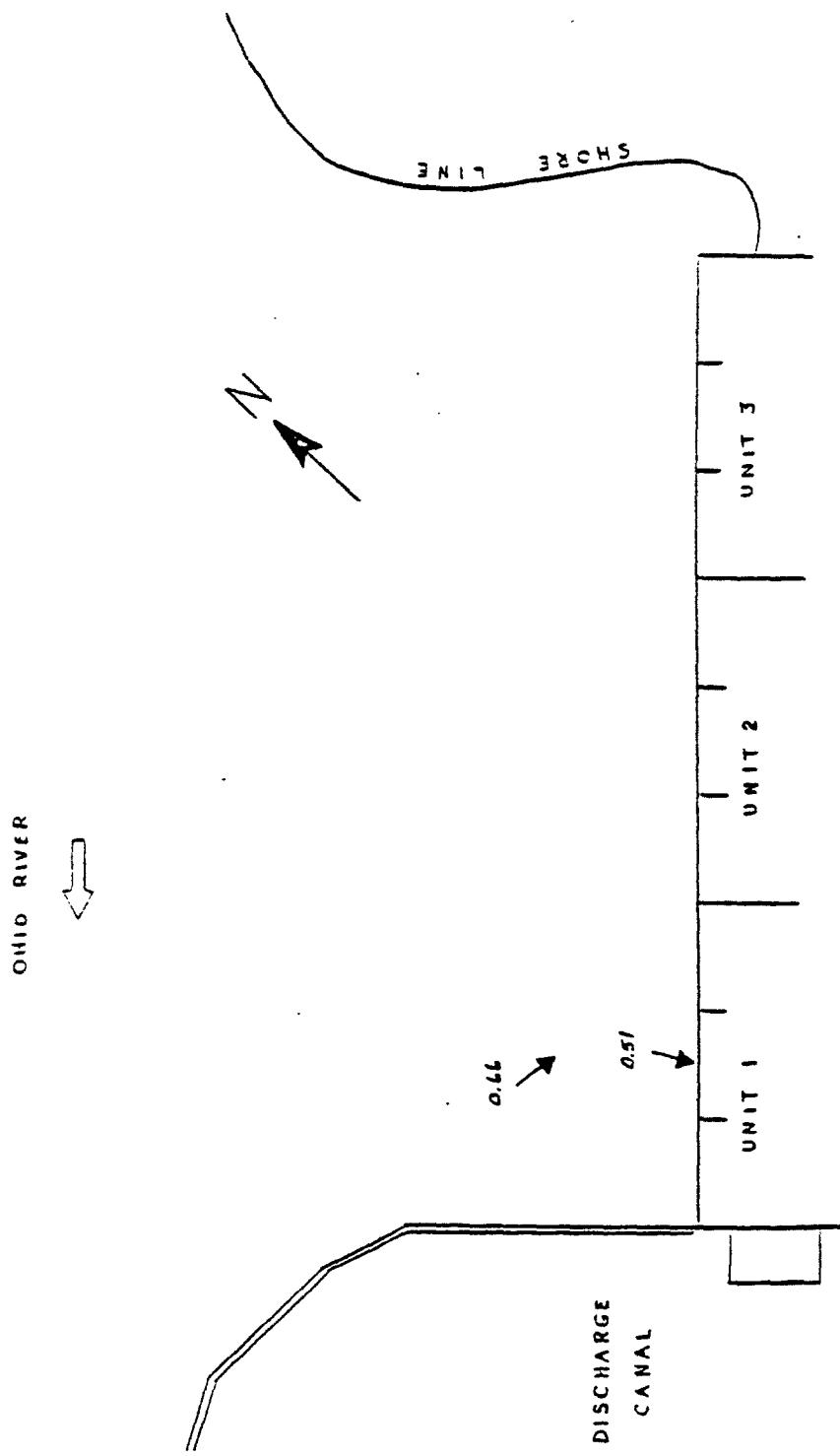


FIGURE 9
VELOCITY (ft/sec) AND DIRECTION OF CURRENTS IN FRONT OF THE
KAMMER PLANT INTAKE STRUCTURE
SEVEN METER DEPTH READINGS

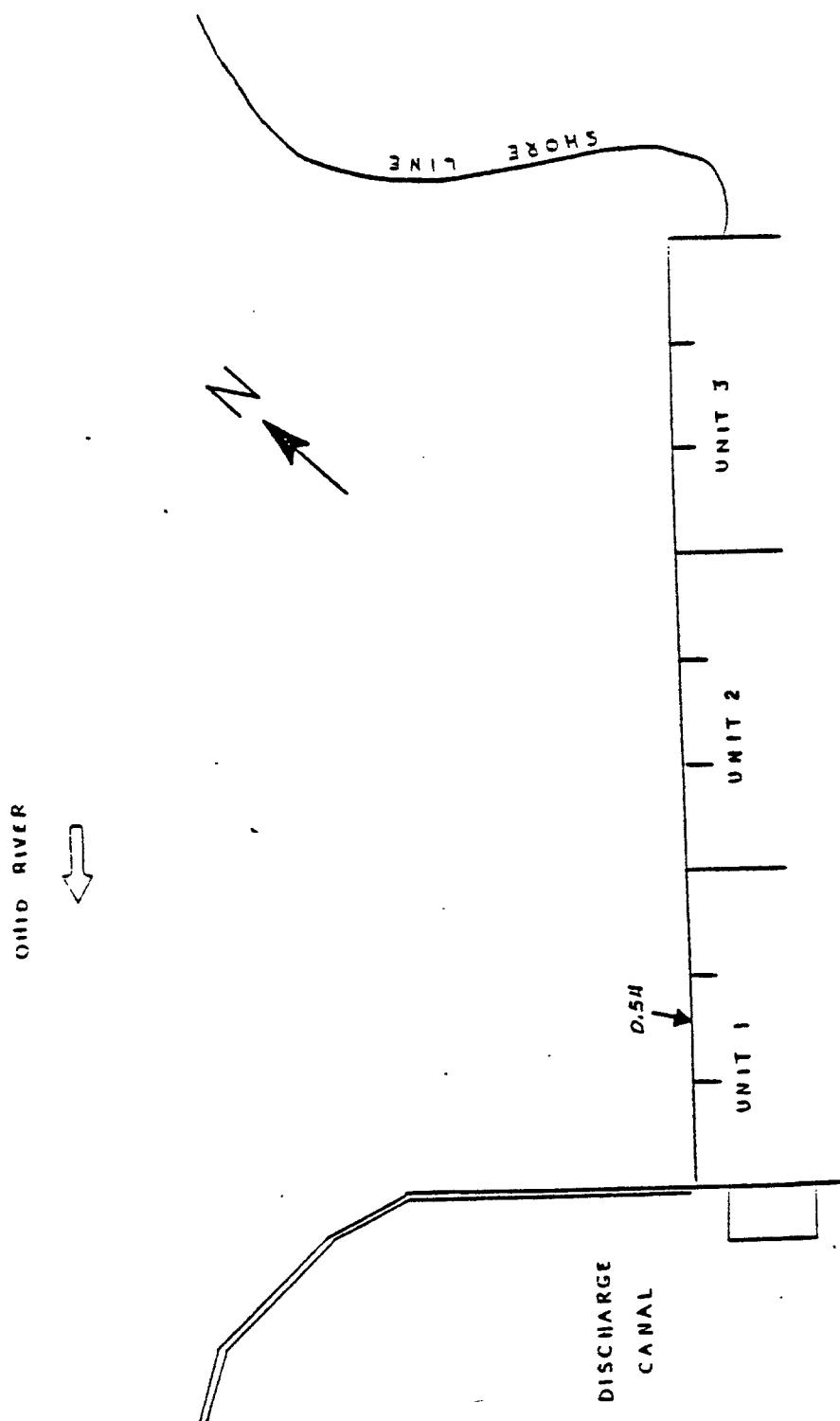


FIGURE 10
VELOCITY (ft/sec) AND DIRECTION OF CURRENTS IN FRONT OF THE
KAMMER PLANT INTAKE STRUCTURE
EIGHT METER DEPTH READINGS

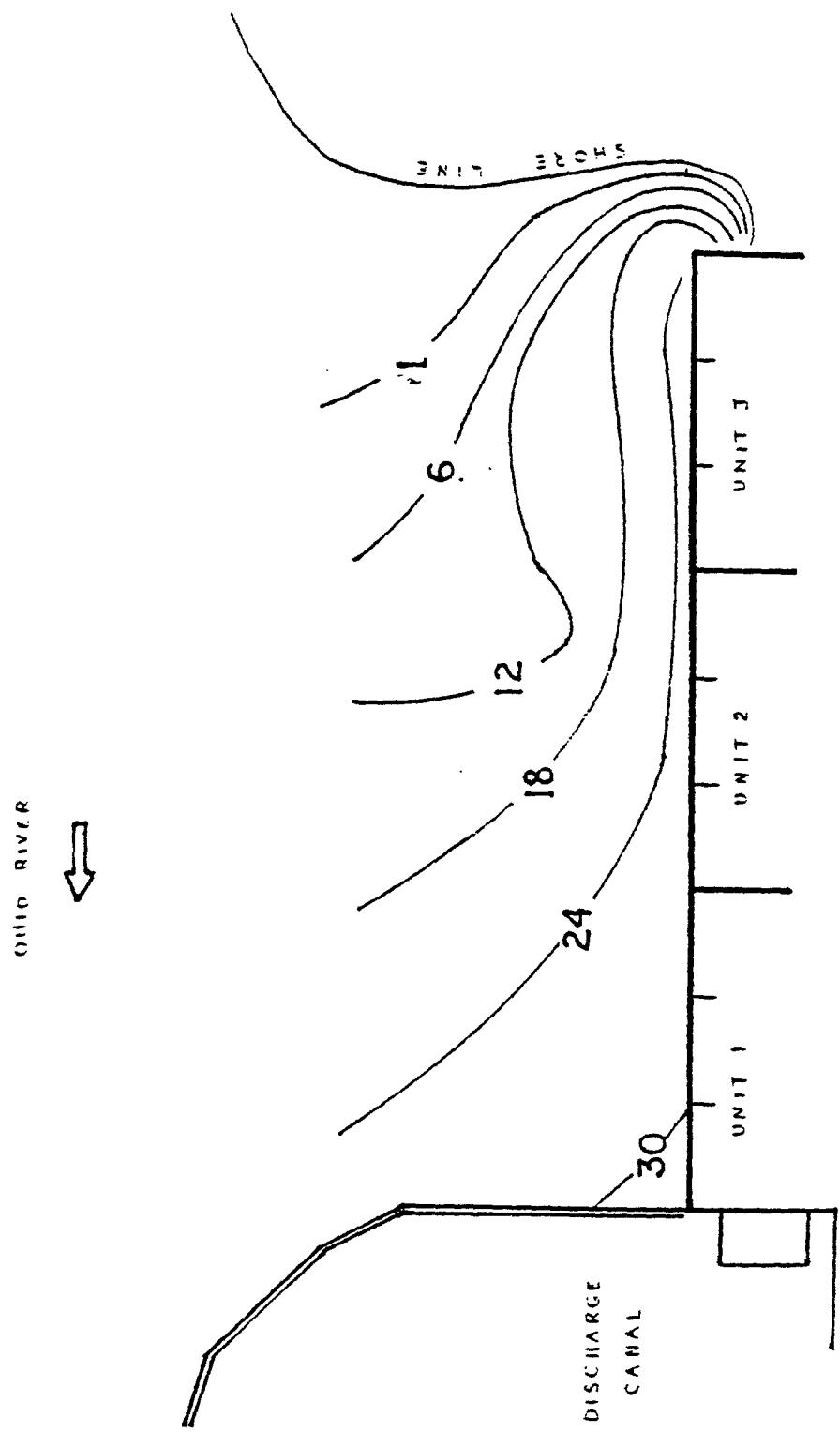


FIGURE 11

BOTTOM ISOPLETHS (ft) IN FRONT OF THE KAMMER PLANT INTAKE STRUCTURE
JULY 16, 1979

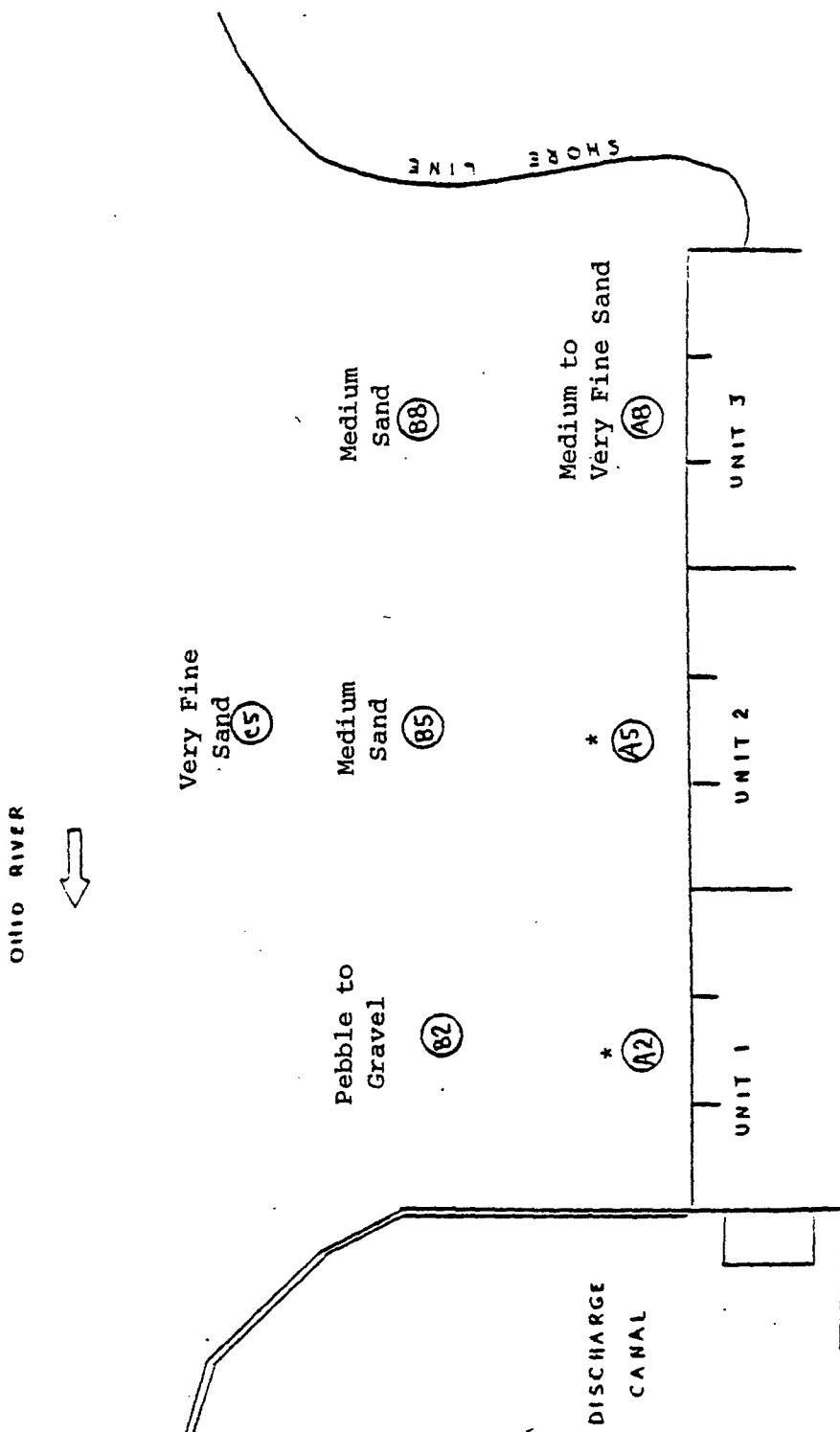


FIGURE 12

LOCATION AND DESCRIPTION OF BOTTOM SEDIMENTS IN FRONT OF THE KAMMER PLANT INTAKE STRUCTURE
SAMPLES COLLECTED ON JULY 11, 1979